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THE NORTHWESTERN ELEVATED RAILWAY, of Chicago, upon which work has been suspended for nearly two years, is to be pushed to completion as soon as practicable. According to press reports, negotiations have been completed for a loan of $4,500,000, which will be used to continue the work. This loan was received through Blair & Co., of New York city, and is to be financed by notes of the railway company payable on or before 18 months, with interest at 5%. To secure the loan the railway company will deposit with the Illinois Trust & Savings Bank as trustees, $5,000,000 in 5% first mortgage gold bonds and $5,000,000 in preferred stock, representing the entire issue of both classes of securities. As a guarantee that the railway company will at once proceed with the construction of the road and have it completed by Jan. 1, 1900, it has deposited $100,000 with the Comptroller of the city of Chicago. The Northwestern Elevated Ry. will extend from the business district into the northern section of the city of Chicago, and will be about 6¾ miles long. The motive power will be electricity. The foundations for a considerable part of the line are completed and much of the steel work is ready for erection. A full description of the proposed road was published in Engineering News, of Sept. 5, 1895.

A PLANT FOR THE MANUFACTURE OF STEEL cars is about to be built by the Carnegie Steel Co., Ltd., It will have a capacity of about 40 cars per day, and will include a large axle forge. The company has purchased a large track of land on the south bank of the Monongahila river, west of Homestead. It is about 1½ miles long by from ⅛ to ¼ mile wide. With this new track the company will own over seven consecutive miles of land on the river. The establishment of a car works by the Carnegie company is a notable example of the tendency of iron and steel manufacturers not only to control their own coal and ore supplies and their own transportation, but also to carry the manufacture of their product to the final shape in which it is to be used, instead of selling it in intermediate forms, such as bars, beams and plates.

PROPOSALS FOR TURBINES for the water power electric plant of the Lake Superior Power Co., at Sault Ste. Marie, Mich., will be received until March 1, 1899. A full description of the canal, penstock and power-house construction for this plant was published in Engineering News, of Aug. 4, 1898. The turbines which are required must be capable of developing in penstock units, composed of two or more turbines, with a head of 16 ft. at the penstock entrance and with 391 cu. ft. of water per second, 568 HP. at the end of a shaft, which revolves 180 times per minute. The details of construcuon, type, size and number of the turbines are left to the bidder. The proposals are to be submitted to the Chief Engineer, Lake Superior Power Co., Sault Ste. Marie, Mich.

A $9,000,000 LOAN AT NEW ORLEANS for water supply, sewerage and drainage will be submitted to popular vote on Feb. 2. If the vote is in the affirmative, the proceeds of the loan will be divided equally between the works named. The city is already part owner of the water-works, and work on the drainage system is under way. A franchise for a sewerage system was granted a number of years ago, a company organized and some pipe laid. The company has been in the hands of a receiver for some time.

THE SANITATION OF SANTIAGO DE CUBA requires strong measures to impress upon the inhabitants the force and meaning of the new regulations. Major Barbour, with his force of 126 men, has dug out and carted away very much of the accumulated filth of centuries, and whitewash, lime and disinfectants have greatly improved the sanitary conditions of the city. But doors of houses have had to be smashed in getting at filthy yards, and natives who insist upon turning the streets into sewers are publicly horsewhipped in the streets. Eminently respectable citizens were at first sentenced to aid in cleaning the streets, when convicted of defiling them; but all classes have completely surrendered now, says Mr. Robert P. Porter, in his report as Special Commissioner, and they begin to appreciate the common good to result from the new regime. Several important streets have been repaved and all the public buildings thoroughly cleaned. The law courts have been reorganized; and the municipal taxes, formerly diverted into other channels by Spanish officials, are now being devoted exclusively to local improvement. Public roads are greatly needed in the Province, as practically none exist worthy of the name. Mr. Porter says there is a nominal revenue of nearly $5,000,000 annually, in Santiago Province, coming from internal, industrial, professional and licensing taxes, and this could well be devoted to local improvement.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred Dec. 21 on the Pennsylvania R. R., at Colonia station, near Rahway, N. J. Two persons were killed and six seriously injured, all of whom were on an express known as the "Pittsburg Flyer," due at Jersey City at 6:21 a. m. Owing to a dense fog the Southern express, from Tampa, due at Jersey City at 6:43 a. m., ran into the rear of the Pittsburg express, which was being held by the block signal.

TWO WATER MAINS BURST IN CLEVELAND on Dec. 21. One was 30 ins. and the other 8 ins. in diameter, the breaks being close together. A large hole was washed out in the street and some other damage was caused by the water.

HEAVY MARINE LOSSES, for 1898, are reported by marine insurance men. A list of the 26 most important total losses foots up at $4,325,000 for the approximate hull value, and $7,397,500 for the freight cargo. In this list "La Bourgogne" figures at $800,000 for the ship and $500,000 for cargo; and the "Mohegan" at $700,000 and $150,000, respectively. On the American lakes, 56 vessels were lost, with a tonnage of 29,194 tons, valued at $2,600,000.

THE SINKING OF A PIECE OF STATE ROAD in Swampacott, Mass., is reported in the Massachusetts papers. A stretch of road has given some trouble by continued settling, requiring the addition of new material from time to time to keep it to grade. On Dec. 8, as filling was in progress, alarm was caused by heavy settlement. The settlement continued until quite a pit, filled with water, is said to have formed over a length of 100 ft. of what had been roadway. It appears that an embankment was built on a thin crust of solid material; that settling began, and was made worse by each successive filling, until finally the crust gave way under the load. The road was built by, or under the direction of, the Massachusetts State Highway Commission, whose headquarters are at Boston.

THE TRANS-CASPIAN RAILWAY, says the London "Times," has been extended from Merv, 300 miles southeast of Khwa, to Kushk, in the Jamshidi province of Afghanistan and within 95 miles of Herat. The first train passed through on Dec. 16.

THE MOMBASA-UGANDA RAILWAY, in East Central Africa, is completed for 250 miles, from Mombasa, on the Zanzibar coast. The terminus will be on the north shore of Lake Victoria. The line is one meter gage, and for fully 200 miles it traverses a waterless desert. At 131 miles from Mombasa, at Tsavo, it reaches an elevation of 1,900 ft. above sea-level; at Kibwesi, 193 miles, the elevation is 3,000 ft.; and at Kikuyu and Mau the line will be 7,700 ft. and 8,300 ft., respectively, above the sea. The road was constructed under great difficulties; but the portion completed is being operated with first, second and third-class cars, moderate fares and with time-tables arranged on the 24-hour system.

GEOLOGIC FOLIOS, or the parts of the geological map of the United States already surveyed and mapped by the U. S. Geological survey, are on sale at the offices of the Survey, at Washington, D. C. A circular has been prepared, and will be forwarded on application, showing for each folio, the state, the limiting parallels and meridians, the area covered, and the price, which in nearly all cases is 25 cts. The area covered by a folio is usually 1,000 sq. miles; 46 folios are ready for distribution and 15 are nearing completion.

TOPOGRAPHIC MAPS OF NEW ENGLAND are on sale by the U. S. Geological Survey as follows: Massachusetts, Rhode Island and Connecticut are completely surveyed and mapped; of Maine, 24 sheets are published; of New Hampshire, 19 sheets, and of Vermont, 23 sheets. The whole number of published sheets for New England is 133; of which Massachusetts has 55; Rhode Island, 15, and Connecticut, 34. The unit sheet is 16½ × 20 ins., covering 1-16th of a "square degree," embracing an area of about 220 sq. miles, on a scale of 1:62,500, or about one mile to one inch. They are sold for 5 cts. per sheet, or 2 cts. each for 100 or more sheets. On application a circular will be forwarded showing just what parts of the three unfinished states are surveyed; and on this circular, the separate sheets of all work done are so designated that maps for any desired section can be ordered.

SHIP DRAFTSMEN are wanted at various shipyards, and on Feb. 7 the U. S. Civil Service Commissioner will open a competitive examination of applicants. The pay is $5 per day for draftsmen, and $4 for assistant draftsmen. All persons desiring to compete should at once write for application blanks and directions to the U. S. Civil Service Commission, Washington, D. C.

SURVEYS OF PORTO RICO HARBORS are to be made by the U. S. Coast and Geodetic Survey, and the survey steamer "Blake" sailed from Baltimore on Dec. 22 with a party of engineers. The government will extend this work as rapidly as possible to the whole coast of Cuba and Porto Rico, which is either now very poorly mapped or has never been surveyed at all.

THE PROPOSED LAKE ERIE-OHIO RIVER SHIP canal is not believed in by the Pittsburg Chamber of Commerce, according to the "Commercial Gazette," of that city. At a recent meeting of the directors of the Chamber, a resolution was presented favoring the incorporation of the canal company by Congress and urging Congress to pass the bill. This resolution brought out vigorous opposition. Capt. Jno. F. Dravo said that the plans for the canal call for a depth of 15 ft., whereas nearly all lake vessels draw from 18 to 20 ft.; and at the proposed terminus of the canal, at Davis Island, there is only 12 ft. of water. To make the canal available, locks 1 and 2, in the Ohio slack-water navigation, would have to be rebuilt, and the river would have to be dredged from the Island to McKeesport. This dredging would destroy Pittsburg harbor, as the water is now held by the natural bar at Brunot's Island, which bar would have to be cut through. Mr. Dravo criticised the estimated cost as too small, and finally said that the building of the Carnegie railway line to Lake Erie had killed the canal as an enterprise. Other directors spoke in a similar vein, only one favoring the canal. In the interest of the subscribers to the canal fund, the resolution was finally adopted, although a number of the members did not vote.

COAL FOR AMERICAN WARSHIPS, to the amount of about 500,000 tons, is to be systematically distributed along the Atlantic, Gulf and Pacific coasts, at Manila, Honolulu, Pago-Pago, Guam, etc. In addition, at least 50,000 tons more is always available at either Hampton Roads or New York. The government now possesses 17 armed colliers, with an aggregate carrying capacity of 50,000 tons.

THE FIGHTING FORCE OF THE U. S. NAVY, at its maximum on Aug. 15, 1898, according to the report of the Secretary of the Navy, was made up as follows: First class battleships, 4; second class, 1; armored cruisers, 2; coast-defence monitors, 6; armored ram, 1; protected cruisers, 12; unprotected cruisers, 3; gunboats, 18; dynamite cruiser, 1; torpedo boats, 11; vessels of old Navy, including monitors, 14. Auxiliary Navy: Cruisers, 11; converted yachts, 28; revenue cutters, 15; lighthouse tenders, 4; converted tugs, 27; converted colliers, 19; miscellaneous, 19. This is a total of 73 in the regular navy, and 123 in the auxiliary fleet, or 196 vessels in all. This fleet was manned by 24,123 enlisted men. There were 856 volunteer officers of all grades in service during the war; 456 of these ranking with the line, and 205 were engineer officers. There are now under construction: 8 first-class battleships; 4 coast-defence monitors; 1 training vessel; 1 sheathed cruiser; 16 destroyers; 22 torpedo boats; 2 steel tugs; 1 submarine boat; or 55 warships in all.

A 40-FT. CHANNEL TO NEW YORK HARBOR is advocated by New York business and marine interests before the House Committee on Rivers and Harbors. This channel, by way of the East Channel, would cost $5,840,000, and could be finished in ten years. A 35-ft. channel would cost $4,510,000, but in view of the rapid increase of the draft and dimensions of ocean steamers the deeper channel is recommended.

## NEW RUSTIC STONE ARCH BRIDGES IN THE NEW YORK STATE RESERVATION AT NIAGARA FALLS.

The Commissioners of the New York State Reservation at Niagara Falls have been replacing several of the older bridges by rustic stone arches. The largest of these, which has just been completed, is one connecting Goat Island with the First Sister Island, and it takes the place of the old suspension bridge familiar to every visitor to Niagara Falls. This older bridge was too narrow for the traffic, and being located some feet above the present stone arch, it obstructed the view of one of the prettiest of the small water falls at Niagara. The new bridge was so built that the fall can be seen, and the channel was deepened above the bridge to increase still further the beauty of the scene.

RUSTIC STONE ARCH BRIDGE CONNECTING GOAT ISLAND AND FIRST SISTER ISLAND, NIAGARA FALLS, N. Y.
Vaux & Emery, New York, N. Y., Architects.
A. Shepard & Co., Niagara Falls, N. Y., Contractors.

The span of the arch is about 60 ft. and the outside width is 16 ft., with parapet walls 2 ft. thick. The arch is built of "native" stone, used undressed on the face and laid with ½-in. joints in Giant Portland cement. The rock-face projects about 3 ins. beyond the plane of the joints, and the general character of the masonry is well shown in the photograph. In construction the arch was laid uniformly from both ends, and all backing, wing walls, etc., are made of first-class random rubble-work laid in courses and well bonded. The top of the arch and part of the abutments have a concrete backing plastered over with cement, and on this is laid a three-ply damp-course made of tarred felt and asphaltic cement. Four 3-in. weepholes through the abutments carry away any moisture reaching the damp-course. At each end of the arch are projecting bays, and from these the wing walls extend. The parapet-wall is made of two courses of rock-face stone, and a cement walk completes the bridge. Judging from the photograph alone the chief criticism to be made upon this arch is that it is somewhat too massive in appearance for the span and site.

The architects were Vaux & Emery, of New York, and the work was done by W. A. Shepard & Co., of Niagara Falls, at a cost of about $8,000. We are indebted to Mr. Orrin E. Dunlap, of Niagara Falls, for the photographs and information used.

## A WOODEN LINING FOR SHIELD-DRIVEN TUNNELS.

In the construction of the sewerage system of Melbourne, Australia, a large amount of tunnelling was necessary; in all, 37,145 lin. ft. of sewers, from 3 ft. 3 ins. to 9 ft. internal finished diameter, were built with the assistance of shields. Compressed air was employed in 5,250 lin. ft. of this work, and cast-iron, wood, concrete and bluestone blocks were used for lining. The cast-iron, with concrete lining, was first adopted, but the great extent of the work demanded some more economical construction, and concrete and bluestone blocks were next tried. This latter system of lining was not found to be generally suitable, especially in wet grounds and in the larger diameters, and, for a time, iron lining was again employed. In the last shield tunnel work, however, a system of lining with wood, devised by Mr. George Henry Dunlop, M. C. E., of Melbourne, was successfully adopted. This tunnel was finished in concrete, as with the cast-iron lining.

For two lengths of sewer, one amounting to 2,000 lin. ft. of 6 ft. 9 in. tunnel and the other 1,250 lin. ft., 7 ft. 6 ins. in diameter. Mr. Wm. Thwaite, M. Inst. C. E., and Engineer in Chief of the Melbourne Metropolitan Board of Works, had two designs prepared, one using cast-iron lining of the usual type and the other the wood lining proposed by Mr. Dunlop. The two constructions were deemed of equal efficiency for use with shields and alternative bids were received upon the two plans. As a result, the lowest bid for the cast-iron was $164,000, and $121,300 was bid for the wooden lining. The bid for the wood lining was accepted; but it should be said in connection with these prices that a considerable part of each sum was chargeable to shafts and other non-tunnel work common to both.

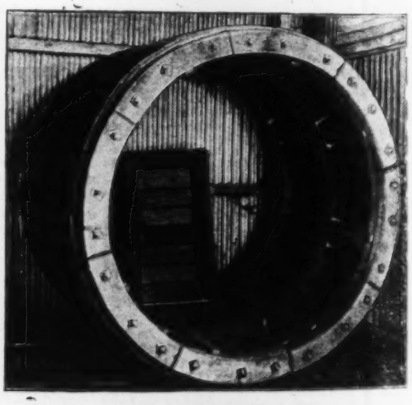
The construction of the wooden lining is shown in the illustration given for a 4 ft. 3 in. sewer. The wooden lining is built up in successive rings, about 2 ft. broad, each ring being made of eight segments fastened together by the lagging nailed to them. In the sewers here shown the ribs were made of 5×3 in. material, cut to the circle and radial lines, and the lagging was 1½ ins. thick. The sections are put together outside of the tunnel, and are laid up like blocks in the tunnel; and as they are put in place the rear-rib is made to break joint with the rib already laid, and the two are firmly bolted together, so as to act as one piece. As a consequence, each complete rib is actually made of two sets of the 5×3 in. timbers. In construction, freshly tarred felt is placed between the abutting ribs. The bolts used are ¾-in. diameter, with square heads and nuts, and washers 2½ ins. square and ¼-in. thick.

To take up the thrust of the rams used in forcing the shield ahead, eight stout struts, or thrust-blocks, are fitted between the ribs with wedges, and in continuous lines extending as far back from the shield as may be necessary. These struts are removed before the concrete is put in place and they may be used over again. In these Melbourne sewers Australian hardwood was employed, and red-gum, ironbark, and box was specified for the ribs. In the 7 ft. 6 in. circular sewers the ribs were made of 6×3 in. red-gum; the lagging was 1½ ins. thick, with 10 pieces to each of the eight segments; the thrust-blocks were 8×6 ins. in section, and ¾-in. bolts were used throughout. Each ring was 2 ft. long, and the final concrete lining was 14½ ins. thick, with a rendering of ¾-in. of neat cement mortar on the inner surface. The ground passed through was largely a sandy clay, with a considerable section containing only sand heavily charged with water. This tunnel was carried under several railways, a small creek, and the brick abutment of a bridge.

In designing this wood lining the purpose is to make the ribs, taken in connection with the lagging, sufficiently strong to resist the outside pressure, for a considerable time at least; and as a matter of fact, at Melbourne, sometimes as much as 2,000 lin. ft. of the wood lining was built ahead of the concreting work. The chief advantage claimed for the wood over the iron lining, aside from economy in cost, is the better subdivision of duties to be performed by the ribs and lagging. Any tunnel lining, when unequally loaded, depends for its rigidity upon its ribs, or flanges. In cast-iron lining the circumferential flanges usually contain from 25 to 33% of the whole metal, and it is difficult if not impossible to separate the duty performed by the flanges and the metal connecting them. In a properly designed wood lining, the ribs would contain from 50 to 66% of the total wood; and this material and the span and thickness of the lagging can be readily and certainly proportioned to sustain any estimated compression. The use of the continuous thrust-blocks prevents the rings from being distorted by ram-action, and for all practical purposes the wooden lining is as rigid as one of cast-iron.

It is true, that there is an unusually large number of joints in the wood lining. But the swelling of the wood in damp ground will tend to prevent leakage; and if it were necessary, the whole outer surface of the ring could be covered with thin metal or other waterproof material—even overlapping the joints of rings. While the timber lining requires a slightly larger shield, this is compensated for by the lighter weights to be handled in wood construction. The lagging, if closely fitted, will swell, and to a considerable extent act as an arch in transmitting pressure to the ribs. In fact, the wooden lining used at Melbourne was found to deflect less under pressure than the cast-iron which it replaced; and it well withstood heavy and unequal ram pressures.

In large tunnels, lined with cast-iron, it is a common practice to omit the concrete, or only to cover the flanges with concrete, on the assumption that the life of the cast-iron used is equal to that of brick or concrete. In construction of this kind to be used in connection with electric power, there is now a suspicion of possible serious trouble from electrolytic action. Based upon the experience in Melbourne, the inventor of the new system believes that an all-brick or concrete tunnel could be thus built at a less cost than for an



General View of the Dunlop Wood Lining for a 4-ft. 3-in. Sewer, Built at Melbourne, Australia.
(This sewer, when finished, had concrete walls 13 ins. thick; the wooden ribs being imbedded; but the longitudinal struts were first taken out.)

unlined cast-iron tunnel, and it would be totally free from danger of the kind mentioned.

The following comparative tables of quantities are given from actual experience with the two systems:

FIG. 1.—TUNNEL EXCAVATION IN THE CENTRAL LONDON RY., LONDON, ENG., SHOWING INTERIOR OF GREATHEAD SHIELD AND THE ELECTRIC CHAIN CUTTER USED.

FIG. 2.—ENTRANCE TO AIR LOCK IN 11½-FT. TUNNEL, CENTRAL LONDON RY.

Quantities Per Lineal Foot for a 7-ft. 6-in. Circular Sewer.

| | Cast-iron lining. | Wood lining. |
|---|---|---|
| Cast iron, lbs. | 1,820 | .... |
| Bolts, lbs. | 56 | 34 |
| Concrete, cu. yds. | 1.07 | 1.23 |
| Rendering, sq. yds. | 2.70 | 2.70 |
| Wood ribs, B. M. | .... | 82 |
| Boarding, B. M. | .... | 55 |
| Nails, lbs. | .... | 6 |

To the above must be added labor and plant.

Quantities Per Lineal Foot for 4-ft. 3-in. Sewer.

| | Cast-iron lining. | Wood lining. |
|---|---|---|
| Cast iron, lbs | 1,012 | .... |
| Bolts, lbs. | 54 | 29 |
| Concrete, cu. yds | .40 | .50 |
| Rendering, sq. yds | 1.53 | 1.53 |
| Wood ribs, B. M. | .... | 40 |
| Boarding, B. M. | .... | 34 |
| Nails, lbs. | .... | 2.3 |

Add labor and plant for erection.

Any further details regarding this process may be obtained from Mr. Wm. H. Breithaupt, M. Am. Soc. C. E., 35 Nassau St., New York city, who is the representative of the inventor, Mr. Dunlop, in the United States.

## SOME NOTES OF THE CENTRAL LONDON RAILWAY.

By Gilbert Rosenbusch, M. E.*

While conducting tests on the first elevator installed by the Sprague Electric Elevator Co., of New York (Eng. News, Nov. 3, 1898), for the Central London Ry., it was my good fortune to be able to inspect this interesting underground railway, and to procure, through the courtesy of Mr. Cowperthwaite, assistant to Sir Benjamin Baker, the chief engineer, some photographs of the tunnel work. These are here reproduced as being characteristic and of interest to American engineers.

This road, it will be remembered, consists of twin deep level tunnels, constructed with the aid of the well-known "Greathead" shield system. The principal reasons for using twin tunnels with a single track in each, one for up trains and one for down trains, in preference to a double track single tunnel were: First, the lower initial cost; second, ability, by reason of small diameter and change of relative position, to remain under the roadway proper; thus complying with the acts of Parliament which precluded the right of way under private property; third, avoidance of the possibility of collisions as the result of derailment; fourth, maintenance of ventilation due to the draft caused by continued passage of trains in one direction only.

The objections to this method were: First, increased cost of maintenance of way, inspection and signaling; second, increased cost, and complication of inlet and egress passages at stations, with relatively greater discomfort to passengers; third, inability to switch over en route.

In the construction, the need of rapid acceleration and quick braking, without greatly increased power consumption, or wear and tear on the running equipment, was provided for by "peaking" the road bed at each station, the approaching grade being 1 in 30 and the leaving grade 1 in 60. Otherwise, the road bed is practically level; the depth at various stations varies considerably, being from 40 ft. to over 100 ft. The majority of the work being through black London clay, which is extremely hard and dense, air pressure is generally dispensed with, being used only at the Shepherd's Bush end, where gravel was encountered, and again where the work went under the supporting piers of the Holborn Viaduct at Chancery Lane, where a pressure of 20 lbs. per sq. in. was used. At these places air locks were necessary, and Fig. 2 shows the entrance to one of the air lock chambers. These entrances are boiler shells about 7 ft. in diameter, and about 10 ft. long, or sufficiently large to hold two loaded muck wagons. The doors are hinged, and, of course, open only toward air pressure, locks being found unnecessary. This air chamber is held in place by a brick bulkhead, 12 ft. thick, also shown in the figure, which takes the pressure of the air on the remaining area of the tunnel (about 165 tons).

The men employed work on 8-hour shifts, being taken only with a doctor's certificate of soundness. They receive pay for time and a third, and are furnished with hot coffee at the air locks when they desire it.

The air compressors are situated in the open on the street level, the supply pump opening being kept close to the heading, thus insuring a constant supply of fresh air. The air-lock tender has telephonic communication with the compressor room.

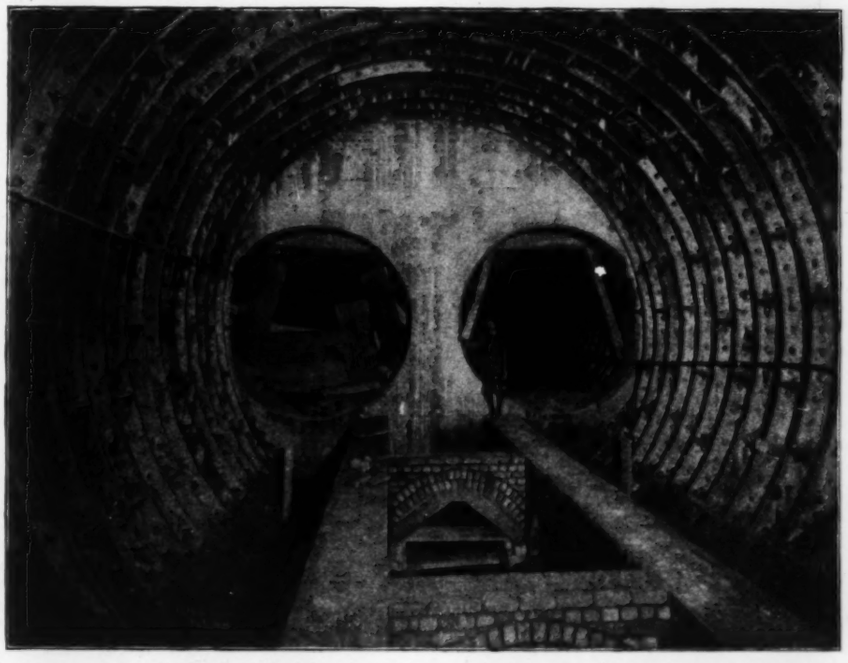


FIG. 3.—VIEW SHOWING LARGE TUNNEL AT STATIONS AND CONNECTION WITH SMALL TUNNELS.

The tunnels are driven by a steel shield worked with six hydraulic jacks operated by a hand pump and cutting out a tunnel 1 in. larger in diameter than the outside of the tunnel lining. This lining is built up of cast-iron rings 18 ins. wide, and consisting of 6 segments and one key, the latter having parallel sides is slipped in from the front after the 6 segments are in place. These segments weigh in the neighborhood of 5 English

*Engineer with the Sprague Electric Elevator Co., 44 Broad St., New York city.

hundred-weight (560 lbs.), and the contract for furnishing them was sublet to a number of foundries, because of the enormous quantity of cast iron involved. In the small tunnels they are erected by hand and bolted together in place, following as closely behind the advancing shield as working room will permit. The finished inside diameter is about 12 ft., with a working diameter of 11½ ft. The resulting series of circumferential and longitudinal joints are rust calked with sal-ammoniac and metal filings, and then carefully grouted. In places where the soil was of softer character a traveling bucket excavator, shown in Fig. 1 (also Eng. News, May 19, 1898), was used to great advantage, the moving mechanism being mounted on a wooden boom so as to be pointed at any spot desired, like a derrick.

As the shield bores 1 in. in diameter larger than necessary, a ½-in. recess is left all round the iron, which permits of an outside water-tight lining. This is done by forcing through holes in the segments by air pressure a grout of hydraulic lime which sets in about 15 minutes, thus affording additional proof against the entrance of water to the tunnel.

The road bed proper is built up in the tunnel to the proper level by filling in with concrete, with a top layer of cement, on which are laid longitudinal wood stringers upon which the 100-lb. rails, are bolted. The resulting low head room precluded the use of motor cars unless the car bodies were made like those used by the Waterloo & City road, in which, however, valuable seat room is sacrificed, owing to the large and high motor required. The company, therefore, adopted a locomotive system. (Eng. News, June 9, 1898.)

At stations the tunnel is enlarged for a length of about 500 ft. to 21 ft. in diameter to take a platform. An excellent idea may be gotten of this arrangement from Fig. 3. It will be noticed that where the twin tunnels enter the station tunnel, the latter is, for a short distance, considerably larger in diameter. This enlargement was allowed for the setting up of the shield.

Of course where the tunnels are on different levels, and have different vertical center lines, two enlarged station tunnels are necessary. These station tunnels, which are constructed exactly similarly to the smaller road tunnels, will be lined with a white vitreous material 1 in. in thickness bedded into cement, and having the effect of, and doing the duty of, glazed brick at a much reduced cost.

The station tunnels were also constructed with shields, which were made 22 ft. 10 ins. in diameter and 6 ft. in length. They were built of two cast-iron rings, strengthened and braced by steel stringers, running vertically and horizontically. A central diaphragm of steel plate was bolted between the two cast-iron rings. Each ring was made up of 22 segments, and there was a hydraulic ram for each segment.

## LIFE ON A RAILWAY SURVEY IN THE WOODS.

We are indebted to Mr. E. T. Abbott, of Minneapolis, for a photograph, reproduced herewith, of a railway location party equipped for a fifty-mile survey in the forests of Minnesota and Wisconsin, last October. In a breezy letter accompanying the photograph, Mr. Abbott wrote:

> Those who take their luxurious ease in parlor cars, after the road is built, ought to get a taste of the life of the men who first laid out the route over which they ride in such comfort. At this time of year a "bell-ringer" is necessary in surveying in the woods to prevent some city "pot-hunter" taking a shot at you for a deer. Notwithstanding our precautions, twice during the fall some one of my party has been fired at with a Winchester rifle. Thanks to bad marksmanship, however, no harm was done. Wolves are numerous, and we have occasionally had to keep fires all night to keep them away from the camp.
>
> It may be of interest to know the contents of the kit of supplies, which we packed on our backs in our fifty-mile survey, so I append it as follows: One 12x14-ft. 10-oz. duck tent, 14 pairs blankets, 2 axes, 1 tin bake oven, 1 frying-pan, 6 tin cups, 6 tin plates, 6 knives and forks, 6 spoons, 1 bread pan, 1 dripping pan, 1 wash basin, 25 lbs. flour, 25 lbs. ham, 10 lbs. bacon, 6 lbs. corned beef, 3 tin pails, 2 lbs. tea, 10 lbs. coffee, 5 lbs. butter, 10 lbs. mess pork, 10 lbs. sugar, 20 lbs. canned peaches, beans, baking powder, condensed milk, etc.; 25 lbs. extra clothing, rubber sheets, etc., etc. No guns, revolvers, cards or whiskey. All the above was carried in the packs shown in the photograph.

The bags with shoulder straps, which are shown in Mr. Abbott's photographic view, call to mind another form of "pack," the making and carrying of which are fully illustrated by the sketches on the opposite page. To make this pack a tarpaulin and a "tump-line," or "pack-strap," are needed. The tarpaulin may be from 7 to 8 feet square, and is useful for many other purposes, particularly to lay on the ground under the blankets. The tump-line consists of a head-strap of leather about 3 ins. wide by 2 ft. long, to each end of which are attached leather thongs about 7 ft. long. A pack so made is thoroughly waterproof and may be varied in size and form to suit the nature of its contents.

BLAZING THE WAY FOR THE PALACE CAR; RAILWAY SURVEY PARTY EQUIPPED FOR A FIFTY-MILE TRIP THROUGH THE WOODS.

Mr. Abbott does not state what time was spent on his survey, but his list of provisions shows that he carried 25 lbs. of flour and about 50 lbs. of meat. This proportion is not in accord with the experience of a member of the staff of this journal who has spent some thirty months surveying in six different seasons, on Canadian Government work. His notes show the average consumption of the staples to be 2 lbs. of flour and 1¼ lbs. of preserved meat (salt pork, ham, etc.) per man per day.

## MARITIME COMMERCE; PAST, PRESENT AND FUTURE.

At the fiftieth meeting of the American Association for the Advancement of Science, at Boston, Mass., Mr. Elmer L. Corthell, M. Am. Soc. C. E., presented a paper with the above title, of which the following is an abstract:

The purpose of the paper is to note the changes that have taken place in the last half century in the methods of maritime transportation, from sail to steam, and from wood to iron and steel. It deals with the effective carrying power of the commercial navies of the world, the dimensions of ocean vessels and the facilities of harbors and ports. Mr. Corthell, from such data as are available and within the limits of future and unforeseen conditions, attempts to estimate the dimensions of vessels, and the requirements in harbor approaches fifty years hence. He does this so that those having to do with public works of this description may at least form some idea of what may be demanded of them in the future. He plots these results in diagrammatic curves; and he approximately projects these curves forward twenty-five or fifty years. In obtaining this information, he has personally visited some forty ports of Europe; consulted those qualified to give an opinion, and has carefully studied a great list of authorities given in the paper. The chief end of all these studies is to ascertain the depth and dimensions to be given to sea-approaches to harbors, to meet the possible demands of the next half century following increased dimensions in ships themselves.

In 1848, Lloyd's Register of British and Foreign Shipping shows that the commerce of the world was almost altogether carried in sailing vessels built of wood. There were only 121 steamers afloat in that year, and only 36 of these were built of iron; and of the 10,579 sailing vessels described only 79 were built of iron. The development prior to this date had been slow and tentative. The first attempt to propel vessels by steam power was made in Barcelona, Spain, in 1543; then in France in 1707; in England in 1736; in the United States by John Fitch in 1787; then by Robert Fulton in 1807, and on the Clyde in 1812. At the latter date steam navigation may be said to have been fairly under way. The first steamer to cross the Atlantic was built in the United States, at Savannah, Ga., in 1819, by John Stevens. But steam was only an auxiliary to sails. The first British Atlantic steamer was the "Royal William," built in Quebec in 1831, and it crossed in 1838. The first Cunarder crossed in 1840; the first steamer of the Collins Line in 1848; and the first vessel fitted with a screw propeller was the "Francis B. Ogden," built by Capt. Ericsson in 1837. The first screw steamer to cross the Atlantis was the "Great Britain," in 1845, and she was also the first iron steamer to cross the ocean.

The fastest passage, between Liverpool and New York, up to 1840, was made by the Cunarder "Europa," in 11 d. 3 h.; in 1852 this time was reduced by the Collins Line's "Baltic" to 9 d. 13 h. The "Royal William," above referred to, made the passage from Quebec to London in a little over 40 days. She was 160 ft. long, 44 ft. beam, 17¾ ft. deep and 363 tons' register, or about the size of an ocean tug of the present day.

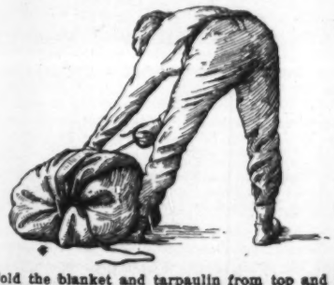
Mr. Corthell does not note the comparative dimensions of modern ocean steamers, their sailing time, etc., as these are matters of record elsewhere, but he proceeds to generally point out the effects of the continued increase of steam navigation, in all lines, in the last fifty years. The increase in the number, size, speed and economy of steamships has augmented the amount and decreased the relative value of goods transported. This economy makes it now possible to transport goods of low values long distances; it has brought new countries into the commercial field, and the sources of supply are brought nearer to the markets. The beneficial change is not confined to the sea, as canals and railways have in a similar manner covered immense distances on land and provide transportation for districts far removed from the sea-board. And in the case of railways, the gain is in continually increased hauling power and car capacity; the latter having increased from an average of 10 tons to 30 tons, and even 50 tons.

In 1848, coal, grain, timber and metals, all articles of relatively low values, were transported in the ratio of 9,000,000 tons of these to 7,000,000 tons of more valuable merchandise. This ratio is now as 120,000,000 tons is to 65,000,000 tons of the more valuable goods. This decrease in transportation cost has doubtless had very much to do with the notable fall in prices in these fifty years, as the average prices of all articles of consumption were about twice as much in 1848 as in 1898. In this period the effective horse-power of all steam vessels afloat has increased from 2,000,000 to 40,000,000 I. HP.

In referring to the diagram given in the paper, we find these curves of special interest, made by taking the average of 20 of the largest steamships; Average length: 230 ft. in 1848; 541 ft. in 1898; possible 1,000 ft. in 1948. Average beam: 36 ft. in 1848; 61 ft. in 1898; 100 ft. in 1948. Average depth: 23 ft. in 1848; 39 ft. in 1898; 43 ft. in 1948. Average loaded draft: 19 ft. in 1848; 29 ft. in 1898; 33 ft. in 1948. Average speed in knots: 9 knots in 1848; 18 knots in 1898; 24 knots in 1948. Average tonnage: 1,430 tons in 1848; 10,717 tons in 1898; 30,000 tons in 1948. Speed in knots of the fastest steamships: 10 knots in 1848; 22 knots in 1898; 30 knots in 1948. Number of dry-docks, 500 ft. long and more: 23 in 1881; 75 in 1898; 176 in 1948.

The curves of general features give the following general rate of growth: Total number of sailing vessels, 56,281 in 1873; 29,315 in 1898; 10,800 in 1948. Total tonnage of sailing vessels, 14,185,836 in 1873; 8,894,732 in 1898; 3,241,000 in 1948. Average tonnage of sailing vessels, 252 tons in 1873; 303 tons in 1898; 300 tons in 1948. Total number of steamships, 242 in 1848; 5,148 in 1873; 11,271 in 1898; 16,685 in 1948. Total tonnage of steamships, 74,700 in 1848; 4,328,193 in 1873; 17,889,006 in 1898; 45,000,000 in 1948. Average tonnage of steamships, 310 tons in 1848; 841 tons in 1873; 1,587 tons in 1898; 2,700 tons in 1948. Power of steam and sail, in millions of tons, on the basis of one ton of steam equivalent to three tons of sail, 16½ million tons in 1848; 27 millions in 1873; 62½ millions in 1898; 138 millions in 1948. Weight of seaborne commerce, in millions of tons, 26½ million tons in 1848; 113 million in 1880; 201 million in 1898; 435 million in 1948.

2.—Upon the pad thus formed lay first your blankets; then anything hard you have to pack—say an instrument box; on top of this place all the soft things you can.



3.—Fold the blanket and tarpaulin from top and bottom over all; then take hold of the head-strap and each end of the tie-strap, alternately, haul them tight until you have puckered the ends of the tarpaulin close over the contents. Make a half-hitch of the tie-strap round the head-strap at either end.

If the growth of the tonnage in the principal ports of the world be compared with the general increase of commerce, we have additional evidence of the remarkable increase brought about by steam transportation. Selecting twelve characteristic ports, and commencing with 1832, when steam navigation was practically not in existence, we have the following:

| | | |
|---|---|---|
| 1832, | total tonnage of arrivals | 4,832,828 |
| 1887, | " " " | 54,879,222 |
| 1895, | " " " | 68,965,483 |

1.—First spread your tarpaulin; lay your tump-line across it, with the tie-straps from two to three feet apart, depending on the size of the pack; then fold the ends of the tarpaulin over the tie-straps.

The draft, or depth, of vessels is now restricted by the depth and width of channels in harbor entrances and through outlying bars, or river channels, leading to basins and docks. The author says that if these dimensions are not increased the size of steamships will not much further increase; and in such case the limit of the carrying power and economies of commerce is in sight. Further, and according to Dr. Francis Elgar, the designer of the "Campania" and "Lucania," if the draft of the ship were not restricted, the form of section in the hull could be improved by giving it more rise of bilge and an easier curvature. And as the displacement is increased by increase of draft, the power required to drive a ton of displacement at a given speed is reduced. Hence,

4.—Bring the remaining part of the ends of the tie-straps across and around the bundle; then take hold of the head-strap at either end and lift.

increase of draft does not mean a proportionate increase in engine power, even when such increase is obtained merely by extra immersion without any improvement in form, such as would otherwise be possible. The advantages of increased draft would be felt more in a seaway than in smooth water, as the lower part of the hull would be less affected by the wave surface, and better and more constant immersion could be given to the propellers.

The engineer must here assist the naval architect in any further development in maritime transportation. All that the employers of engineers have thus far felt justified in doing or expending the engineer has done or is doing. But it is safe to say that, in the near future, no port in the world will be classed as a first-class port which will not readily admit vessels drawing 30 ft. of water. This means 35 ft. in the entrance channels through sea-bars; 32 ft. in river channels and other entrance approaches, and 31 ft. in harbors and basins, and alongside docks and wharves.

As to what is being done to secure this depth we have the Suez Canal, the key to the harbors of Europe and Asia, built with a depth of 26 ft., deepened to 28½ ft., and planned for 30 ft. The Amsterdam Canal has been deepened from 23 to 30 ft.; the new Kaiser Wilhelm Canal has about 30 ft.; the Liverpool channel has 30 ft. at low tide, or a channel entrance depth of from 27 to 57 ft., according to tide; Southampton has 30 ft., and New York will soon have 35 ft. at low tide; Boston and Philadelphia will have 30 ft. New Orleans is asking for a least depth of 35 ft. over the bar and 32 ft. in the South-West Pass and the River; Galveston, under present plans, will have 30 ft.; Antwerp has a sea-entrance of 30 ft., a river depth of 31 ft. at high water, and a projected port depth of 32½ ft.; Hamburg, in the near future, will have a deep channelway to the sea adequate for the largest vessels.

5.—Throw the pack over the head onto the shoulders; settle the head into the head-strap, easing the backward pull by grasping the strap with the hands; then off you go.

## THE NEW DOUBLE SCREW FERRY STEAMER "BERKELEY," OF THE SOUTHERN PACIFIC CO.

One of the largest ferry steamers which we now recall has just been put in service by the Southern Pacific Co. on its San Francisco Bay ferry line between the foot of Market St., San Francisco, Cal., and Oakland Pier. This vessel has been named the "Berkeley," for the city of Berkeley, Cal., located on the eastern side of San Francisco Bay, and the seat of the University of California. It was designed and built by the Union Iron & Shipbuilding Works, of San Francisco, Cal., after the general specifications of the Southern Pacific Co. Mr. J. Kruttschnitt, Vice-President and General Manager of the railway company, has furnished us with the general details and dimensions of the steamer, which are given here.

6.—And if, after a mile or so, the bundle feels irksome, you may make a change by putting the strap across the chest and letting the pack fall so that its weight rests on the ribs.

The "Berkeley" is a double screw steel boat, driven by engines of the inverted cylinder, direct-acting, triple expansion type. The hull is con-

structed entirely of steel, and has, including the bulkheads at the ends of the screw shaft, seven complete steel bulkheads without openings below the main deck, and two bulkheads with small openings for the transfer of coal from the bunkers to the boiler room. Between these bulkheads are located the crew's quarters, engine room, boiler room, restaurant, wine room, and toilet room. Access to these various compartments is had only from the main deck, making the boats safe against sinking in case of damage to the hull.

The main deck has a seating capacity of 580 passengers; a toilet room, reached by a stairway from the saloon deck, and two driveways for baggage and for mail and express trucks and wagons. A single stairway at each end of the boat connects the main and saloon decks. The saloon deck has a seating capacity for 997 passengers in the cabin, and for 132 outside, making the total seating capacity of the boat, 1,709 passengers.

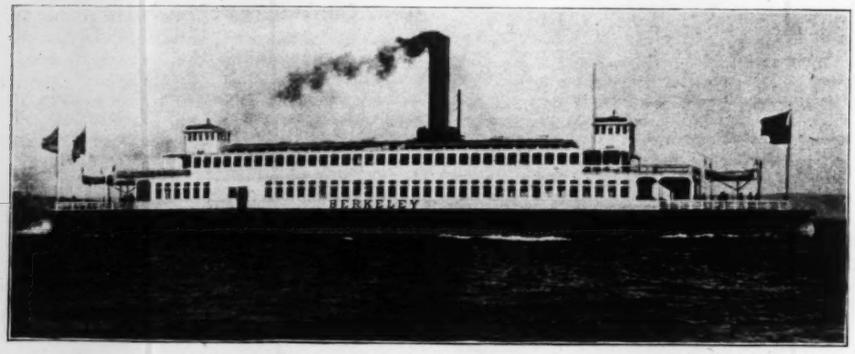



FIG. 1.—THE NEW SCREW FERRY STEAMER "BERKELEY" OF THE SOUTHERN PACIFIC CO.
The Union Iron & Shipbuilding Works, San Francisco, Cal., Builders.

The cabin seats are constructed of perforated black walnut on teak wood frames. The floor covering is interlocked rubber tiling. The cabin is painted dead white with gold leaf ornamentation. The clear-story is glazed with art glass. Ventilation and heating is provided for by the plenum process, pipes being provided for the inlet of fresh air and the efflux of vitiated air. The boat is lighted throughout by electricity.

The rudders of the boat are operated by a steam steering gear. A special feature of this boat is its numerous large windows, glazed with plate glass, and set at such a height from the decks that an unobstructed view of the bay of San Francisco can be had from all the seats. Under ordinary running conditions, the trip between San Francisco and Oakland Pier, 4½ miles, is made in 17½ minutes. The principal dimensions and details of the vessel and machinery are as follows:

| | |
|---|---|
| Length over all | 289 ft. |
| Length inside rudder posts | 260 " |
| Beam, molded | 40 " |
| Beam over wood guard | 64 " |
| Depth molded at guard | 16 ft. 6 ins. |
| Depth molded at center | 17 " 0 " |
| Depth of hold | 14 " 10 " |
| Draft, extreme load | 8 " 6 " |
| No. of propellers | Two—one at each end. |
| Diameter of propellers | 8 ft. |
| Revolutions per minute | 125 |
| Registered tonnage, gross | 1,945 tons. |
| Registered tonnage, net | 1,245 " |
| Type of boilers | "Scotch." |
| Horse-power | 1,450 |
| Boiler pressure | 165 lbs. |
| Cylinder diameters | 23, 34 and 56 ins. |
| Stroke | 36 ins. |

Second story landings are provided and used at both the San Francisco and the Oakland Pier depots, a large proportion of the passengers being thus handled to and from the depots on the saloon deck level. Referring to the illustrations, Fig. 1 is a general view of the vessel; Fig. 2 is a view on the saloon deck, showing the arrangement of the seats and the appearance of the interior finish and decorations; Fig. 3 gives half transverse sections of the steamer through the engine room and boiler room, and Fig. 4 is a plan of the hull.

## NOTES FROM RECENT REPORTS OF CITY ENGINEERS AND OTHER MUNICIPAL OFFICERS.

Repairs to macadam streets in Boston, according to the last report of Mr. Benj. Wells, Superintendent of Streets, are successfully and economically made by first picking up the surface with spikes attached to the wheels of steam rollers, then giving the street a light dressing of stone and rolling it.

The Ferry Division of the Street Department has installed electric motors for assisting teams on and off the boats at extreme stages of tide. The running time of the boats has been improved by the installation.

Concrete gutters in place of macadam have been found necessary on the Commonwealth Ave. Boulevard, in Newton, Mass. Such gutters were included in the original estimates, but as the work progressed it was thought that they could be dispensed with. It was found that the combination of frost and moisture was causing the disintegration of the macadam, and that wheel ruts were cutting down to the foundation. Contracts were let in 1897 for putting in 3-ft. gutters on all the steeper grades. Mr. H. D. Woods, M. Am. Soc. C. E., is City Engineer of Newton. Mr. Wood's report for 1897 contains a review of work done during the year in the abolition of grade crossings, illustrated by numerous reproductions of photographs.

A special feature of the last report of Mr. E. A. Fisher, M. Am. Soc. C. E., City Engineer of Rochester, N. Y., is a table showing the cost of asphalt paving in a number of cities when reduced to a proper basis of comparison with Rochester, ordinary excavation and a 6-in. concrete foundation. The consecutive columns in the table are as follows: Name of city; year of return; reported price; percentage of correction; corrected price, for 5, 10 and 15-year guarantees; security required; cash reserve and bond; kind of asphalt laid; amount laid, and remarks. Mr. Fisher took his original figures from replies to a circular sent out by himself, from a report by Mr. F. W. Capellen, City Engineer of Minneapolis, and from notes made while on tours of inspection to other cities. These figures should be suggestive to those city officials who are met with wild statements regarding the low comparative cost of paving in other cities, without regard to the relative character of the work and local conditions.

A report on the apportionment of the cost of a proposed joint outlet sewer for a small section of Newark and a number of adjoining or near-by communities, has recently been made by Mr. Alex. Potter, Assoc. M. Am. Soc. C.E., of New York city. Mr. Potter reviews at some length the methods employed heretofore in the distribution of the cost of joint municipal works, and finally recommends a plan summarized by him as follows:

> The apportionment recommended will be based upon the amount of sewage contributed by the possible ultimate population of each district or municipality, determined by a detailed examination of the physical characteristics and environments of the various municipalities, and a study of the water supply of each.
>
> Further, that the absolute right shall be granted each municipality or district to own, control and dispose of so much of the cubical capacity of the outlet sewer as is proportionate to the percentage of the total cost of the joint outlet which is borne by each municipality or district.

Unfortunately, so limited a number of copies of this report were printed as to make their distribution, on application, impossible.

Heavy rainfalls in Philadelphia are cited in the last report of Mr. Geo. S. Webster, M. Am. Soc. C. E., Chief of the Bureau of Surveys, as follows:

FIG. 2.—VIEW ON SALOON DECK OF THE SOUTHERN PACIFIC CO.'S FERRY STEAMER "BERKELEY."

> June 8 to 9, in 21 hours, 2¼ ins.; July 19 to 23, 5 ins. On Aug. 19, 1.34 ins. fell in 3½ hours. The greatest intensity of rainfall occurred Oct 12, when for a space of five minutes the precipitation was at the rate of 2¾ ins. per hour. Aug. 23, for 15 minutes the rate was 2½ ins. per hour. At that time the water in the sewer (6 ft. in diameter) on Lombard St. near Third St., rose 4¾ ft.

The effect of the best material and workmanship upon the carrying capacity of pipe sewers is well illustrated by the extract given below, from the last report of Mr. T. Chalkley Hatton, M. Am. Soc. C. E., Engineer in Charge of Sewers, at Wilmington, Del. The sewer in question is for foul liquid wastes, only, and serves an area of 931 acres, and a population of about 46,500 people. The sewer, and tests of it, are described by Mr. Hatton as follows:

> The total length of this sewer is 15,102 ft., and its mean average fall is 5.75 ft. in 1,000 ft. It is composed of 3,-

691 ft. of 18-in. terra cotta pipe, standard thickness, on a grade of 6.5 ft. per 1,000 ft.; 2,106 ft. of 20-in. terra cotta pipe, double strength, on a grade of 6 ft. per 1,000 ft.; 6,952 ft. of 24-in. terra cotta pipe, double strength, on a grade of 8 ft. per 1,000 ft.; and 2,953 ft. of brick and concrete sewer, from 2½ × 3¾ ft. to 5 ft. in diameter, on a grade of 2 ft. per 1,000 ft. Its total cost has been $43,546. This includes the amount paid the contractor, inspectors' salaries, costs for right of way, incidentals and office expenses. Three per cent of this cost was paid for inspection, and when you consider the nature of the work this percentage is very small.

Owing to the nature of the fluids which have to be carried through this sewer (they being the thick liquid wastes from a morocco shop principally, of which a large percentage consists of hair, lime, scraps of skins and other heavy matters), and because but a small portion of the capacity of the sewer would be needed for many years, I was particularly concerned for its ability to keep itself clean, and to overcome the liability of stoppage as far as possible, the specifications for the pipe, and the laying thereof, were made particularly stringent; we insisted upon having the best pipe in the market, paying particular attention to having them so laid that the flow line of the pipe should not be interrupted at each joint by one pipe being a little bit ..igher or lower than its neighbor. We used hemp in the joints for this purpose, and succeeded in getting an uninterrupted flow throughout, although the 18-in. and 20-in. pipes were not as uniform either in diameter or in circular shape as could have been desired, but were the best we could get, and I desire to here call your attention to the effect upon the capacity of this sewer resulting from this very close inspection; as soon as the sewer was finished and examined, I made a test of its carrying capacity, having a chance to turn into its upper end whatever flow of water I desired for this purpose. We procured eight cork floats, varying in size from 3½ ins. in diameter to 3 ins. by 6 ins. long, and 1-in. thick, there being four different sizes and shapes, one of which was loaded sufficiently to guarantee its being constantly submerged, and its mate being light so that it would float upon the top of the water. With the help of three men and a stop watch I found the velocity of the water running in the 18-, 20- and 24-in. pipes. Averaging the velocity of the eight floats, (although I found but little difference between the velocity of any of them, the loaded ones travelling as fast as the light ones), the result was that the velocity in the 18-in. pipe was found to be 5.75 ft. per sec., the coefficient of friction .011, making its capacity 10 cu. ft. per sec., whereas the calculated velocity before it was built, was to be 4 ft. per sec., its coefficient of friction .015, and its capacity 7 cu. ft. per sec. The velocity in the 20-in. pipe was found to be 6.8 ft. per sec., its coefficient of friction .01, and its capacity 14.8 cu. ft. per sec., whereas the calculated velocity was to be 4.14 ft. per sec., the coefficient of friction .015, and its capacity 9 cu. ft. per sec. The velocity in the 24-in. pipe was found to be 12.47 ft. per sec., its coefficient of friction .0075, and its capacity 39 cu. ft. per sec., while its calculated velocity was to be 5.47 ft. per sec., its coefficient of friction .015, and its capacity 17 cu. ft. per sec.

An ideal park system for a large city, according to a statement by Mr. John. C. Olmstead, in a report to the Board of Public Works, of Indianapolis, should include the following: (1) A central tract for public buildings; (2) a series of small parks; (3) a series of local parks of greater extent than (2); (4) one or more large parks in the outskirts, where one may drive for an hour or two without going over the same roads twice; one or more great reservations, thousands of acres in extent; and (6) parkways connecting two or more of the parks. Mr. J. Clyde Power is Engineer and Superintendent of the Park System of Indianapolis, and has issued a pleasing illustrated report for the year 1897.

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The last report of the Board of Public Works, of Detroit, Mich., contains the results of tests of 5,296 gas meters, new and repaired. Of 2,780 new meters, eight were condemned for registering too fast, 4.22% on the average, and four for registering too slow, averaging 4.67%, and four were condemned for other reasons. Of 2,439 repaired meters, 63 were condemned for registering too fast, 3.98% average, and 22 for being too slow, 5.27%; 14 were condemned for failing to pass gas, not registering, leaking and other causes. Mr. Robt. Y. Ogg is Secretary of the Board, and Mr. Henry D. Ludden is City Engineer.

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A variety of interesting and useful information regarding the streets of St. Louis has been made public by Mr. A. N. Milner, Street Commissioner, in a pamphlet prepared for general distribution. Statistics, extracts from paving specifications, and numerous illustrations are included.

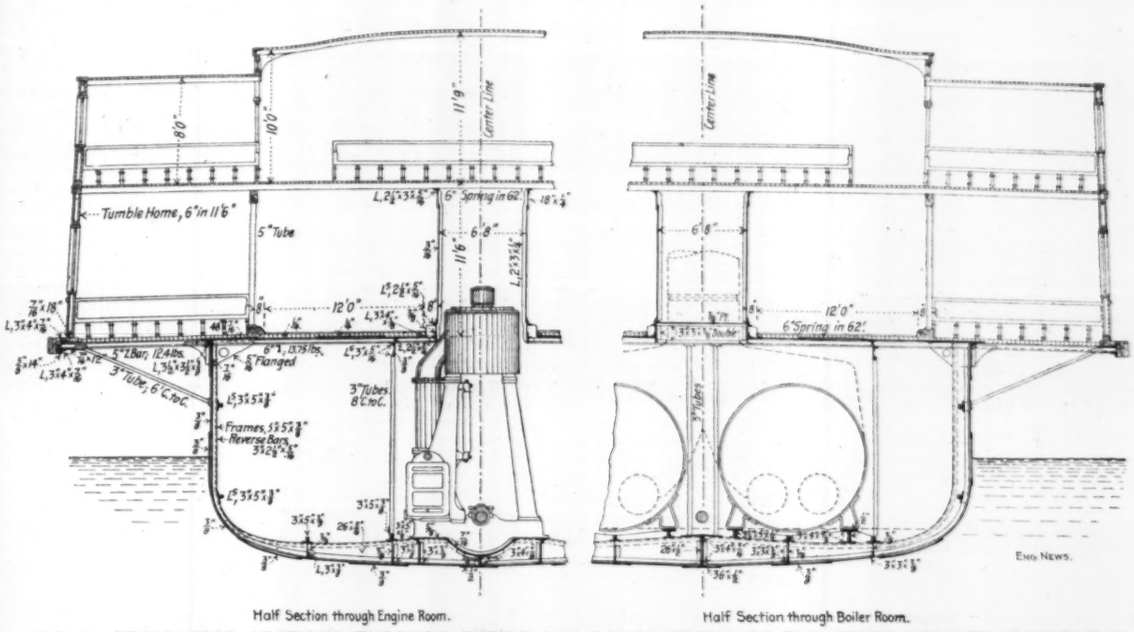


FIG. 3.—TRANSVERSE SECTIONS THROUGH ENGINE AND BOILER ROOMS OF THE FERRY STEAMER "BERKELEY."

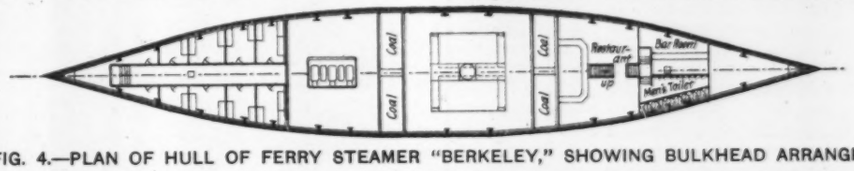


FIG. 4.—PLAN OF HULL OF FERRY STEAMER "BERKELEY," SHOWING BULKHEAD ARRANGEMENT.

The last report of Mr. E. J. Barrow, City Engineer of Hamilton, Ont., contains a brief description of a new sewage disposal plant, the second one built by the city. Chemical precipitation is used at each plant. The plants are located in different parts of the city. A plan and sections of each plant are given in the report. The first plant built was described in Engineering News for Jan. 28, 1897.

## PROSPECTS OF THE KLONDIKE MINING REGION.

An interesting story of the "boom" in the Klondike mining region is told in a paper by Mr. Samuel C. Dunham, in the "Bulletin of the Department of Labor," for November, entitled "The Alaskan Gold Fields, and the Opportunities they offer for Capital and Labor." Mr. Dunham is an agent of the Department, who made an investigation on the ground from Jan. 8, to Aug 1, 1898. We advise any one who thinks of going to the Klondike, or of investing in any of its properties, to obtain a copy of the "Bulletin" and study Mr. Dunham's paper before concluding the arrangements. We quote the following summary:

The Klondike stampede was unique, and it may be interesting to survey the situation briefly with particular reference to its most fascinating feature, the financial result. It is a common assumption among those familiar with the uncertainties of mining for the precious metals, that every dollar's worth of gold extracted from the earth costs somebody at least a dollar in money or labor. Applied to the case under consideration, this assumption is far within the bounds of truth. By actual count, 40,000 men started for and reached the Yukon gold fields during the year beginning with July 15, 1897. It is conservatively estimated that 20,000 more undertook the journey, but were unsuccessful in their efforts to reach the Yukon. It is fair to assume that the average expenditure of these 60,000 men, for outfitting and transportation was $500 each, or a total expenditure of $30,000,000. It is probable that the money invested in ocean and river vessels and the organization of commercial companies for operations on the Yukon would add $5,000,000 to this sum. Without considering the large amounts that have been absorbed in the capitalization of Klondike mining companies, a few legitimate and many wildcat, it may safely be assumed that this great movement during the year following its inception cost the participants $35,000,000, and it is equally safe to assume that in the case of 75% of the individuals involved, their contributions are an absolute loss to them. As against this enormous outlay, we have for the period under consideration, as indicated by the mint returns, a gross product from the Yukon placers of less than $12,000,000.

Although this statement as to the immediate result of the Klondike "boom" cannot be refuted, it would be misleading if allowed to stand without qualification. The condition described is almost entirely due to the exaggerated statements as to the extent of the new discovery so widely published in last year's newspapers and magazines, and should not be permitted to obscure the fact that there is now being developed on the Yukon a mineral zone of wonderful richness, which will eventually contribute hundreds of millions of dollars to the wealth of the world. The lesson to be learned from the present situation is that it will take years of hard work to bring the mines up to their highest point of productiveness, and that the country offers no opportunities for professional men or others who are not equipped by nature for the most exacting manual labor.

# ENGINEERING NEWS
AND
## AMERICAN RAILWAY JOURNAL.

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A new plan for the maintenance of railway rates has been brought forward by the Receivers of the Baltimore & Ohio R. R. They have forwarded a letter to the Interstate Commerce Commission, in which they declare at the outset that:

> Within the territory north of the Ohio River and east of the Mississippi, the railroad carriers are transporting the l...er part of the interstate traffic at rates less than those shown on the published tariffs, filed with your Commission, which are by statute the only lawful rates.

This being the state of affairs, and the voluntary association of railway companies to discover and check discrimination and secret cutting of rates having been declared illegal by the Supreme Court, the Baltimore & Ohio Co. now proposes to appeal to the Interstate Commerce Commission. Beginning on Jan. 1, it will maintain on all its lines the rates for passenger and freight traffic shown on the published tariffs filed with the Commission, and it announces that if any of its competitors depart from their published tariffs, the aid of the Commission will be invoked to stop them.

The working of this new plan for the maintenance of rates will be watched with much interest. Messrs. Cowen and Murray, the Receivers of the Baltimore & Ohio, express the belief that all or nearly all of the railways will follow the B. & O.'s example and begin to maintain strictly the published tariff rate on Jan. 1. It may be of interest to note that by the terms of the Interstate Commerce Law, the charging of a rate different from the published rate is made a misdemeanor, punishable by a fine not to exceed $1,000.

The use of steel for large pipe lines is now becoming so common as to attract comparatively little attention, unless some departure is made from the usual type of construction, or the size or length of pipe is something unusual. The contract for the Coolgardie pipe line, the details of which are given elsewhere in this issue, is notable for both the mode of jointing the pipe and the size of the contract. The line will be 30 ins. in diameter and 328 miles long, but will be practically riveteless. Each section of pipe will be 28 ft. in length, made from two plates, each bent to a half circle and joined by two horizontal locking-bars, each plate edge being dovetailed into one side of a bar and secured there, watertight, by hydraulic pressure, as described in our issue of June 9, 1898. The ends of the 28-ft. sections will be fitted together and the joints formed by an overlapping steel ring, or sleeve, calked with lead. It seems probable that some other type of transverse joints may be used in some cases, whether at regular intervals or under special local conditions we cannot say. Nearly all the pipe will be made from ¼-in. steel plates, less than 2 per cent. in length, being from 5-16-in. plates. The pipe line, as contracted for, differs materially from the recommendations of the advisory English engineers, discussed at length in our issues of Feb. 17 and Oct. 13, 1898. This is largely due to the low bids received on the style of pipe adopted. The English engineers advised the use of 26, 27½ and 29-in. pipe, according to the head, or velocity; that pipe with gas-welded longitudinal joints be used for all pipe ¼-in. thick or over, and that the pipe be laid above ground, on account of the probable action of the salts in the soil on buried pipe. The last recommendation made necessary expansion joints, the design of which we described and adversely criticised in our issue of Oct. 13. Bids, therefore, were invited on 82 miles of welded and 246 miles of riveted pipe, with the results stated elsewhere in this issue. One bidder offered to substitute locking-bar pipe for the welded pipe at such low figures that negotiations were entered upon, which resulted in the adoption of this style of pipe throughout, increased to a uniform diameter of 30 ins., and with ¼-in. plates substituted for the large quantity of 3-16 plates. The changes in size and thickness were effected at an advance of only about $100,000 in the total cost of the pipe, thus reducing the pump friction and adding to the permanency of the line. The adoption of transverse joints, that can be calked with lead, and the placing of the pipe underground "in most cases," will effect a considerable saving in cost. Getting the pipe below ground, and doing away with the expansion joints recommended by the English engineers are changes greatly for the better, we believe. In fact, if the locking-bar and ring joints prove satisfactory, we think Mr. O'Connor will deserve the highest praise for the changes he has made from the design recommended by the engineers. He has done away with all rivets and with changes in the diameter of the pipe every 28 ft., which would have been caused by placing the sections alternately inside and outside of each other. This, coupled with the increase in size, ought to decrease the friction materially, and thus reduce the pumping expenses. When it becomes desirable to sacrifice friction for an increase in capacity, through enlarged demands for water, this can be done, thus delaying the necessity for constructing a temporary pipe line. In our issue of Feb. 17 we stated that it would be foolish to employ an untried invention, like this locking-bar joint, on a piece of work of such magnitude. But since then, as we have already stated, it has been used at Adelaide on 8¾ miles of 26-in. steel pipe, and, we are informed, with entire success. The merits of the device are certainly worth consideration by American engineers and contractors interested in steel pipe manufacture and use.

The condition and prospects of the water-works of Philadelphia are becoming more and more alarming. Urgent improvements are postponed from year to year. Little or nothing is being done to provide for future needs. Portions of the existing works are improperly cared for, some of the costly pumping plant being housed under a temporary board shelter. Nothing is being done to check the rapidly increasing waste of water, although the per capita consumption has reached an enormous figure. The character of the water is notoriously bad, and has been for years, yet practically nothing is done to improve it. The works are being slowly wrecked by the refusal of appropriations for their maintenance and improvement. The executive branch of the city government has pointed out the needs of the water department time and again, and pleaded for appropriations. But it is all of no avail. Just now some of the councilmen are making a great show of virtue and indignation. We believe most emphatically they assert, in municipal control of the water-works, but if the administrative branch of the city government cannot give us a definite plan for pure water we shall be compelled to contract with some private concern that has the ability to formulate such a plan. This sounds well, but it is very misleading. The department of public works, and the bureau of water, have repeatedly asked for appropriations to make investigations of water purification, but have never received a cent. Had such appropriations been granted, when first asked, several years ago, not only plans, but purification works, might now be ready. The appropriations having been denied, the water department has been helpless during the months and years of agitation, giving ample opportunity for promoters to work out detailed plans meanwhile. To a city councilman who seldom or never drinks water and who cares infinitely more for the success of his party and the length of his purse than for the health or interests of his constituents, it may seem a light task to prepare plans for the purification of 200,000,000 to 300,000,000 gallons of water per day, but to any other mortal the problem becomes a serious one the moment he begins to give it practical consideration. The cities of Providence, Louisville, Pittsburg and Cincinnati have not hesitated to spend months of time and thousands of dollars in studying the problem of purifying much smaller quantities of water, and had Philadelphia taken up the study at the same time, with the same civic and scientific spirit, it might have solved it or been near a solution ere this.

That Chicago, of all places in the world, should be afflicted with a plague of snails must be set down as one of the most remarkable occurrences of the year 1898. According to a report submitted to City Engineer Ericson by Prof. Frank C. Baker, snails have appeared in large quantities in the Lake View water supply, and their eggs are found in great numbers upon the screens at the opening of the Lake crib. The prospect that the mollusks will accumulate in the tunnels and finally die and contaminate the water is now causing no small anxiety to those responsible for the city's water supply.

Just why the peaceful snail should choose the floating anchor ice around the Chicago intake cribs as a place in which to display its reproductive powers, must be counted as one of the unsolved problems of biology. Its natural habitat would seem to be the water supply of Philadelphia; but in recent years that has become too bad for even snails to endure.

### A FEASIBLE PLAN FOR THE NEW YORK RAPID TRANSIT RY.

For more than a dozen years has the project for an underground rapid transit railway up and down Manhattan Island, to be constructed with the aid of the city's credit, been before the public. At various times the construction of the road has seemed practically assured; but some obstacle has always intervened to prevent the actual undertaking of the work. The attitude of this journal toward the enterprise has been uniformly one of friendship. We have held from the outset that hardly a great engineering project of the century offers so sure a financial success as the project to convey passengers up and down the length of Manhattan Island, through the central part of the most densely populated city in the world, with a saving of half or more of the time required for the journey.

But while we have recognized the great merit of the scheme as an engineering and financial proposition, we have also been well aware of the difficulties which have hedged it about. The existing Rapid Transit law is a hodge-podge of contradictions. It prescribes a financial scheme for the construction of the road complicated enough to prevent any responsible contractor from ever undertaking the work, and it surrounds the whole enterprise with restrictions and red tape enough to seal the doom of the most promising project that was ever planned.

We have consistently favored the policy of

municipal ownership and control, and in some cases of municipal construction of street railway lines. All this has been done, and done successfully; but such a hybrid alliance between city and a corporation as the New York Rapid Transit act proposes was never known on earth. We believe, therefore, that the first step toward the construction of the New York Rapid Transit railway, is not the amendment, but the repeal in toto of the present Rapid Transit act.

Before outlining what should be put in its place, let us discuss briefly certain engineering aspects of the enterprise. The most important feature of the New York Rapid Transit scheme is the provision of a four-track road with two tracks for express trains, stopping only at stations two or three miles apart, and the other two for local trains, stopping at stations ¼ mile or so apart. It is proposed that the local trains shall collect passengers at express stations, and distribute them from these stations. We believe that for the peculiar local conditions on Manhattan Island (enormously heavy traffic concentrated in a single direction), this scheme promises great benefits to the public in the saving of time. We are aware that it has been criticised, and that some have attempted to show that the time saving would be little or nothing over the time of transit by the present elevated railways in the case of a passenger who has to take first a local train, then an express train, and then a second local train to reach his destination. If it were proposed to operate the Rapid Transit road by steam locomotives with such train intervals as are common on the present elevated railway lines, this criticism would have considerable weight. But nobody proposes, or has proposed for many years, to operate the road in that way. With electric motor cars, on both the local and express tracks, having power enough to make a quick start, and running at as short intervals as safety permits, it would be feasible to make a very great time saving, in the journey from New York's business district to its residence district, even when two transfers have to be made.

The original $50,000,000 plan of the Rapid Transit Commission comprehended a four-track road from the Battery up Broadway to the northern limits of the city, with various four-track and two-track branches, which we need not now describe. In the modified plan of the commission, contemplating an expenditure about two-thirds as great, the four-track scheme was still adhered to.

The matter to which we wish to call especial attention, is that while the four-track scheme was an excellent and proper one when it was planned, the march of events has now rendered it obsolete, and it is no longer the best or wisest plan of furnishing real rapid transit for New York city. When the Rapid Transit scheme was originally planned, the surface street railways of New York were operated by horses, or in a few instances by cable traction. The coming year will see practically all the main north and south surface lines operated by electricity, and in a manner which leaves little to criticise. In other words: The local tracks for the New York Rapid Transit Ry. have been laid and are now in operation on the surface of the streets.

If the local lines of the proposed Rapid Transit railway were now completed and in operation, they would be forsaken by travelers for the electric cars on the street surface. Passengers will not walk even a block or two and descend to an underground station when they can take an electric car on one of the surface roads at the nearest corner. Further, the rate of speed, including stops, attained on the present electric conduit roads is nearly or quite as good as what the proposed local trains of the New York Rapid Transit Ry. could make.

If these facts are fully understood, it will be at once seen that all that is required for the carrying out of the New York Rapid Transit enterprise, with practically the same measure of public benefit as originally proposed, is to build two-track tunnel roads, for express trains only, beneath some of the principal north and south lines of the present electric conduit system.

Such a two-track tunnel could be built without any difficulties from the destruction of vaults, the interference with building foundations, and the closing to traffic of the entire street that arrayed so many interests against the original Rapid Transit enterprise. Its cost, moreover, would be comparatively very moderate, and it could be built and operated in sections and extended as fast as its success was demonstrated and the public demand warranted.

Of course these proposed express tracks would need to be operated in entire harmony with the present surface railways, and this means practically that they must be built and operated by an arrangement between the city authorities and the Metropolitan Street Railway Co. Such an arrangement, if we may trust the evidence of recent outpourings from the oracle that rules our destinies, is already "in the air," and the coming year may very likely see it placed on a firm basis of fact.

It may be objected that such a plan of construction will not afford the same measure of benefit to the city treasury as would have accrued from the original plan under which the road was to be owned by the city and leased for operation to a corporation. This is doubtless true, provided the original plan of construction could have been carried out, and provided also that conditions had remained the same that they were when it was planned; but it is quite within the possibilities that they would not have remained the same. Had the city undertook the construction of the Rapid Transit system eight years ago, as it came so near doing, it is quite possible that the diversion of traffic which would have ensued when the surface roads adopted electricity might have made the enterprise a financial failure.

Past conditions are past, however, and the conditions which at present confronts the city are these: Should it obtain legislation enabling it to build the four-track Rapid Transit system as originally planned, it is extremely doubtful whether the local lines could obtain sufficient traffic to pay for their operation with the frequent trains and short train intervals which are essential to the system's usefulness. It is evident that the four-track Rapid Transit system, as originally proposed, would never prove profitable from its express train traffic alone. The long distance traffic must be handled in connection with the short distance traffic to make it profitable. Again, should the city adopt the plan we have proposed above and construct a system of double-track tunnels for express train service only, it must operate them in connection with the surface electric roads, and probably a system of transfers between the surface and underground lines would be a necessity to secure a paying traffic.

The whole matter, then, resolves itself into this: The city has one chance, and one only, of securing the system of combined local and express transit up and down Manhattan Island which is so urgently needed. That chance is an arrangement with the Metropolitan Street Railway Co. for the construction and operation of a system of double-track express-train tunnels beneath some of its principal north and south lines.

That such an arrangement could be devised which would promise great benefits to the city, and would at the same time offer great attractions to the railway corporation there is every reason to believe. Whether the Rapid Transit Commission, the present city authorities, the powers behind them, the new state government, and the groups of financiers who control the Metropolitan Street Railway Co. can all be brought into agreement upon such an arrangement, is another and far different question which we shall not attempt to answer.

As we have said above, however, in such a cooperation between the city and this corporation lies the only real hope for the Rapid Transit enterprise. Besides the reasons for this that we have already set forth, there are others of equal or greater force. As everyone knows, the proposition to carry out the enterprise on its original lines, with the aid of the city's credit, has enlisted against it both the present city government, and the political leaders whose word will exercise great influence in shaping legislation at Albany. Besides this, the real estate owners of the city look askance upon the proposition that under a separate county organization further bonds in unlimited amount can be saddled upon the real estate comprised in the Boroughs of Manhattan and the Bronx.

All these facts in connection with a real change in public sentiment toward the Rapid Transit enterprise make the proposition to revive it, on its original lines, a scheme that can be called little less than Quixotic.

On the other hand, the need for real Rapid Transit up and down Manhattan Island grows every year with the growth of that section of the city north of Central Park, and that other and much larger section north of the Harlem River. The speed of the Manhattan elevated trans is 12 to 14 miles an hour, including stops. The electric conduit cars, where streets are not too crowded, make 8 to 10 miles per hour, including stops. These speeds are all right for short trips; but for long journeys they are far too time-consuming to satisfy the reasonable demands of modern life. Let us for a moment see what saving of time would be possible through such an express tunnel system as we have outlined, with stations, let us say, at City Hall, 23d St., 59th St., 90th St., 125th St. and the Harlem River. Let us assume a maximum speed of 40 miles per hour for express trains, and also that stops are made on the average in a distance of 700 ft., and in 30 seconds' time; also that a distance of 1,500 ft. and 50 seconds of time are required for the train to attain full speed; also that an average of 25 seconds is spent at each station in receiving and discharging passengers. The time of express trains from the City Hall to the Harlem River, about nine miles, would then be as follows:

| | Seconds. |
|---|---|
| Stops at 4 stations (25 secs. at each) | 100 |
| Getting under way 5 times (50 secs. each) | 250 |
| Slowing up 5 times (30 secs. each) | 150 |
| Deduct distance run in getting under way (7,500 ft.) and in stopping (3,500 ft.), from total distance leaves 7 miles run at full speed; time to run 7 miles at 40 miles per hour | 630 |
| | 1,130 |

Total time, City Hall to Harlem River..18 mins. 50 secs.

These assumptions of times and distances of acceleration and retardation are made after comparison with the results of actual tests, and it is worth noting that they by no means represent the limit of what is practicable. By arranging the station levels on summits with a sharp descending grade on either side, the time spent in getting up speed and in stopping the train can be considerably reduced, thus permitting either a reduction of the time between terminals or an increase in the number of stations. The stations, however, should not be placed much closer together than is indicated in the above, except, perhaps, toward the terminals at either end of the line. The surface roads should be left to collect at and distribute the passengers from the express stations. Taking average speeds of the electric surface cars at a mile in 8 minutes, and allowing 2 minutes' average wait for an express train, it will be seen that a passenger could ride half a mile to the City Hall express station, take an express train to 125th St., and then take another half-mile ride on an electric car to his destination, all in about 26 minutes.

Of course the above suggestions for the location of stations are merely tentative. We have merely assumed them to make plain that by such a combined local and express service as the new electric conduit railways make practicable, a great saving can be made in the time required for daily travel in this busy city. The benefits of such a time-saving to the city and all its people can hardly be overestimated. It is greatly to be hoped that the Rapid Transit Commission may be able to bring about some arrangement between the Municipality and the Metropolitan Traction Co., by which this improvement may be brought to pass.

## LETTERS TO THE EDITOR.

### One-Story Buildings with Saw-Tooth Skylights for Weaving Mills.

Sir: I have noticed with some curiosity the recent discussion in your journal about the one-story factory at Hammond, Ind. (Engineering News, Dec. 8, 1898), because it seems to have been considered as a novelty in factory construction. As a matter of fact, there have been no less than six buildings of this type, with large "saw-tooth" skylights, built in the Eastern States from designs

made by me within the past three years, one of them covering over two acres in one room. I would not express any opinion as to the merits of this construction for the purposes of the printing company referred to in your articles, as I think a building should always be designed with especial reference to the use to which it is to be put, but for the purposes of weaving, for which all of the buildings designed by me were intended, there is nothing that can equal it. It is an ideal construction for this purpose. I believe I was the first to adopt it to any extent, in the form I have designed, with the very large glass surface, and adapted to New England climatic conditions. The objections you speak of, on the score of fire risk, were fully considered, and, while there is some force in them, they were insignificant in comparison with the great advantage gained, by obtaining a perfect and uniform light, which is the paramount desideratum for weaving.

Yours truly, F. P. Sheldon.

Providence, R. I., Dec. 10, 1898.

### Do They Get Their Engineering Work for Nothing?

Sir: A town in the Middle West, having a population of about 4,500, desires to put in a first-class municipal water-works plant. The mayor invites engineers to submit prices for making plans and specifications for the proposed plant. After receiving bids for performing the engineering services, the town council decides that better and more economical results can be obtained by asking contractors and builders to furnish their own plans and specifications and estimates of cost. It would be interesting to hear from any one knowing the actual experience and results of other towns proceeding in a similar manner.

An Engineer.

Kansas City, Mo., Dec. 21, 1898.

[In asking for bids for a bridge, or a pumping engine, or any piece of machinery whose design can be determined by the manufacturer with comparatively little regard for local conditions, there is much to be said in favor of the plan of permitting the bidder to make his own designs. In constructing a water-works or sewerage plant, on the other hand, it is absolutely necessary that completed surveys be made, before any intelligent design and estimate can be prepared. The town can have one survey made by a competent engineer, and a design made upon that survey; or it can require that every contractor who submits a bid shall go to the expense of making a survey and design on the chance of getting the contract. The latter course will certainly result in crude designs and high bids. Business experience teaches that those who try to get something for nothing generally fail in the attempt. The same rule holds good in the conduct of municipal business.—Ed.]

### Concerning Hydraulic Dredging Patents.

Sir: I have just read in Vol. XL. of the Transactions of the American Society of Civil Engineers the very interesting paper presented by J. A. Ockerson at the Annual Convention in July last, entitled "Dredgers and Dredging on the Mississippi."* I cannot spare time to notice this as I would like, but there is one matter in the discussion of this paper upon which, in justice to my licensees, I feel called upon to make brief comment. This would have been done at an earlier date but for the fact that my absence in Europe prevented it from falling under my notice. In Prof. Haupt's discussion of this paper there occurs the following:

> Under the subdivision of water jets., etc., the writer (Mr. Haupt) is impressed with the failure to refer to the pioneer and basic patent for the system of removing spoils from the bed of a river or bay by means of rotary cutters with inward delivery, centrifugal pumps and flexible distributing pipes as issued to Mr. A. B. Bowers, C. E., of San Francisco, and which has been applied so extensively in various modified forms on rivers and harbors, to the great benefit of commerce. The claims of the patentee have been uniformly sustained by the United States Courts, and the inventor's time is consumed in efforts to protect his interests, the history of which reads like a romance. Active opposition to an invention is, however, the best evidence of its merit. These dredges were used at St. Louis, on the Mississippi; on the Chicago drainage canal; at Seattle, Tacoma, Alameda Bay, and, in modified forms, on the Atlantic and Gulf coasts, with great effect.

Now, Mr. Ockerson's connection with the commission for the improvement of the Mississippi River, especially in connection with the references giving in his closing paragraph, are such as to make his statements authoritative. But, in view of my suit against the United States for infringement of my patents, in the use of this apparatus, it could not be expected of Mr. Ockerson to state that under the numerous decisions of the United States Circuit, and Circuit Court of Appeals, much of the more indispensable portions of these machines are covered by the Bowers' patents. On the contrary, I marvel at his furnishing the facts that prove my contention, and had he let the matter rest here, I should have had abundant reason to be grateful for the service rendered. But, replying to Mr. Haupt, he says:

> In reviewing the discussion it may be well to state that the author did not intend to exhaust the subject in the brief space of a single paper, and purposely omitted descriptions of many channel improvement devices that have come to his notice. It may also be well to state that he aimed to limit himself to devices proposed for, or used, on Mississippi River. With these explanations, Professor Haupt will understand why the author failed to "refer to the pioneer and basic patent," etc., and also omitted the mention of many devices, several of which have been described by Professor Haupt.

Now, in the explanation quoted, Mr. Ockerson has, unintentionally, without doubt, done me an injustice. His language is susceptible of the construction that he does not consider any of the devices described in his paper to be covered by the Bowers' patents. This cannot be true, if he has read the decisions to which I have referred, and he will doubtless thank me for correcting any wrong impression that may have been conveyed, inadvertantly, I am sure, in his explanation.

Yours very truly,

A. B. Bowers.

New York, Dec. 24, 1898.

*Eng. News, Oct. 13, 1898.

### Some Results of a Test of a Hydraulic Cement Containing a Large Percentage of Sulphides.

Sir: Herewith I send you a table of tests made with a certain brand of American cement, the name of which is withheld. The cement was bought on specifications, which required a certain tensile strength after one day in air and six days in water; also a certain fineness on a No. 100 sieve. The samples taken passed the tests given and the cement was accepted. The usual test for change of volume showed no defects, as noted under remarks in the table. The sand tests also were good. The percentages of sulphuric acid and magnesia were thought to be low enough, but the high proportion of sulphides caused the cement to be looked on with suspicion. The cement was therefore used in comparatively unimportant work. Part of the cement so used took a fairly good set, but part of it failed to get hard.

Further tests were then made with the cement. It was found to take a good set in water, but if allowed to dry would lose a great part of its strength, as may be seen from the table. For example, 10 briquettes were put in air one day, then left in water for six days, then removed from the water, and kept in a damp atmosphere at a moderate temperature for seven days more before breaking. These briquettes showed a strength (Table I.) of only 158 lbs. per sq. in.

TABLE I.—Results of Experimental Tests of a Defective Hydraulic Cement.

| No. | Date, 1898. | No. briquettes. | Days In air. | Days In water | Days In air. | Tensile strength, Max., lbs. | Tensile strength, Min., lbs. | Tensile strength, Avg., lbs. |
|---|---|---|---|---|---|---|---|---|
| 1. | July 27. | .. | 1 | 6 | 0 | 564 | 322 | 443[1] |
| 2. | Aug. 18. | .. | 1 | 6 | 0 | 332 | 196 | 213[2] |
| 3. | Aug. 18. | .. | 1 | 27 | 0 | 382 | 300 | 345[2] |
| 4. | Oct. 3. | 10 | 1 | 6 | 0 | 614 | 412 | 496 |
| 5. | " 3. | 10 | 7 | 0 | 0 | 240 | 152 | 203 |
| 6. | " 3. | 10 | 1 | 1 | 5 | 254 | 184 | 229 |
| 7. | " 3. | 10 | 0 | 7 | 0 | 482 | 368 | 451[3] |
| 8. | " 26. | 10 | 1 | 6 | 1 | 286 | 224 | 258 |
| 9. | " 26. | 10 | 1 | 6 | 7 | 182 | 136 | 158 |

Remarks: [1]Pats O. K. [2]Sand test—1 cement 3 sand—pats O. K. [3]Briquettes swollen slightly.

Note.—Fineness = 94.8% on No. 100 sieve; magnesia, (MgO), = 2.25%; sulphuric acid ($SO_3$), = trace; sulphur as sulphide (S), = 1.21%. All samples were from the same lot of 120 barrels.

The experiments Nos. 4-7, under date of Oct. 3, were made simultaneously with similar tests of Atlas American Portland and German Puzzolan cement. In these tests with the Atlas cement, the highest result obtained was 854 lbs. after one day in air and six days in water; the lowest was 765 lbs. after seven days in air only. With the Puzzolan, the highest was 455 lbs. after one day in air and six days in water, while the lowest was 435 lbs., after seven days in air only. Each result was the average of ten briquettes. Hence, we may say that the Atlas and Puzzolan cements do not show an important falling off in strength when removed from the water.

There seems to be no satisfactory explanation for the loss of strength shown in the table, unless one can be found in the high percentage of sulphides, and that does not seem probable. The moral of the above account is that the usual tests of hydraulic cement do not always serve to exclude an inferior brand. The matter is thought to be worthy of space in your journal, as it may prove a valuable hint to those preparing specifications for important work.

Very truly yours,

S. Bent Russell, M.Am.Soc.C.E.

St. Louis, Mo., Nov. 23, 1898.

### Notes of a Visit to the Keely Workshop.

Sir: The notice of the late John W. Keely, in your issue of Nov. 24, recalls an account which he once gave me of the origin of his so-called "motor," which may prove interesting to you. It was, I believe, in the summer of 1880, and during a visit to the workshop in Philadelphia, in company with some intending New York investors who did not invest. The usual exhibitions were made: of pressures of 10,000 lbs. per sq. in., produced after pouring of half a gill of water into the "generator," and the caterwauling of a bass viol; of lead bullets propelled from a gun with violence; of a rotary motor, which wobbled as if driven by a piston engine, and was easily stopped by a brake, etc., etc. In conversation afterwards, I asked Mr. Keely how he happened to discover his "motor." He said that many years previously he had been, for quite another purpose, trying experiments with various substances; that on one occasion these substances and mixtures were enclosed in a number of copper globes, and had been placed temporarily on a window sill. That he approached to remove them, when one of the globes suddenly exploded, knocking him insensible, and so far injuring his face and hands that he had to be put to bed and his wounds dressed by a surgeon. In that bed he laid a week, nearly blind, and mainly striving to remember accurately just what combination of substances he had put into that particular bomb. At last he recollected them all, he made up his mind as to the cause of the explosion, he jumped out of bed, he experimented, and his "motor" was the result.

All the prodigies exhibited to our party could have been reproduced by chemical means; for there are a number of alkali metals (sodium, potassium, etc.), which have so great an affinity for oxygen that they will absorb it from water or damp air, and release the hydrogen, which may reach a high pressure, if confined. The impression left on my mind, by my interview with Mr. Keely, was that it was possible that he was employing one of the alkali metals, perhaps in combination with other chemicals; that the mixture was previously introduced into the "generator," and came into activity upon the introduction of water. I do not claim that this is the way it was done, for I made no experiments, and took no further thought about the matter, being satisfied at the time that whether produced in this or in some other way, the enormous pressures generated were too erratic, and necessarily too small in volume, to be employed as a motive power.

It was also my impression that Mr. Keely originally had taken up his motor in good faith, and had anticipated a great success. After some years, however, he must have had doubts and then discouragements. This probably was the time when he resorted to the big fiddle (he played it very badly), to hasten by vibration the generation of pressure, or the trickling down of water through a narrow aperture, and invented the many puzzling words with which he interlarded his mystifying explanations. Once engaged upon that course, all his ingenuity would be devoted to guarding the secret which furnished him a living.

I hope you will carry out your expressed intention of giving an account of the investigations of your staff into this curious mystification.

Respectfully,

O. Chanute.

413 E. Huron St., Chicago, Ill., Dec. 13, 1898.

### Notes and Queries.

B. K. C., Beaumont, Tex., asks as to the advisability of laying even or broken joints on a light unballasted railway in Southeast Texas.

Broken joints are preferable, and are the most generally approved, making a better running track with less maintenance work in surfacing and lining, especially if plain splice bars are used instead of angle bars. It is sometimes assumed that even joints are better in light tracks, but this is now generally recognized as being incorrect, in consequence of the additional work of maintenance required.

THE MAIN ENTRANCE TO THE PARIS EXPOSITION of 1900, from the Place de la Concorde, is ingeniously planned. The ground plan is an equilateral triangle, surmounted by a dome; one side forming the entering façade. Arranged about the other two sides, in a semi-circle, are 108 passages for visitors, each fitted with a registering wicket. The interior apex of the triangles is cut off, and the dome is here supported on two piers with an arched passage between. This arrangement provides a driveway for special occasions, leading directly through the dome triangle into the grounds. It is estimated that this one gate will easily admit 60,000 persons per day to the Exposition. Architecturally the gate is a failure, but it will cost $38,000 to build.

A DIFFICULT PIECE OF STEEPLE REPAIR is being performed in Boston by John H. Cunningham, of Providence. In the storm of Nov. 26-27, the rod supporting the vane on the steeple of the First Methodist Church was bent over about 50°. A staging was first built inside the top of the steeple, and then a hole, 20 ins. wide by 3 ft. long, was made about 18 ft. below the top. Through this hole a stout stick of timber, 34 ft. long, was pushed up and secured; and on this stick was a tackle and falls by which a boatswain's chair, with Cunningham on it, was hoisted up to the vane. This man first removed the letters on the vane-rod, which were 2 ft. long by 18. ins. deep. The vane itself will be taken down by means of another stick lashed to the first, which will carry a tackle by which it may be lowered to the steeple belfry. None of these adornments will be replaced as they are too heavy for the steeple. The "Lynn" method, here used for work of this character, implies working from the inside of a steeple or chimney, instead of building staging up on the outside, as was once done. In the case of a chimney, 30 ft. timbers are employed, placed diagonally inside and secured, and on top of each is placed another similar stick inclined in the opposite direction, until the top is reached and a secure staging is made. When the work is completed, the lower stick is pulled out and the rest drop to the bottom.

## THE CORNWALL BRIDGE ACCIDENT.

The uncertainty which prevailed at the time of the accident as to the original cause of the failure of the Cornwall Bridge has been cleared away somewhat by recent developments. This bridge crosses the St. Lawrence River in the vicinity of Cornwall, Ont., where Cornwall Island divides the river into two channels, and consists of a cantilever structure over the Canadian channel and a

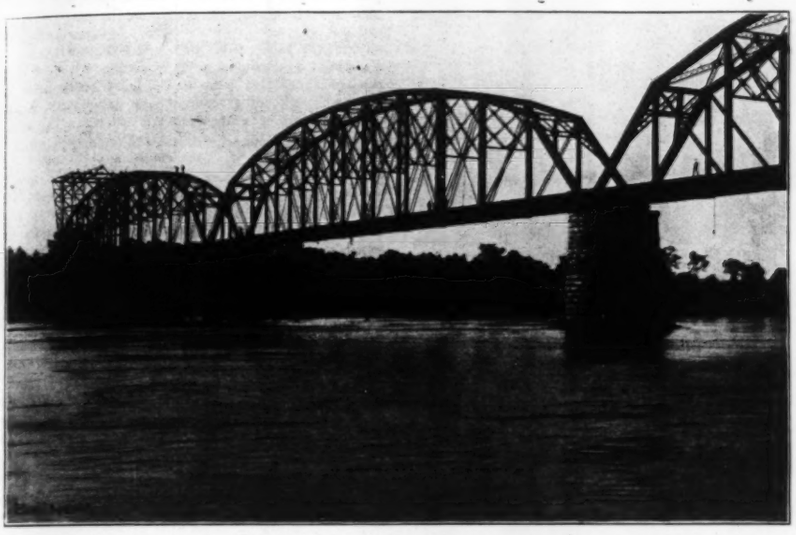


FIG. 1.—THE NEW YORK & OTTAWA R. R. BRIDGE OVER THE AMERICAN CHANNEL OF THE ST. LAWRENCE RIVER, NEAR CORNWALL, ONT.
(From a photograph taken on the morning of Sept. 6. The two spans shown and the center pier fell at noon on that day.)

Pratt truss structure over the American channel. It was to the part over the American channel that the accident occurred (Eng. News, Sept. 15, 1898), and it resulted in the complete destruction of two of the spans and the pier between them. Fig. 1, from a photograph taken only a few hours before the accident, shows quite clearly the condition in which the structure was. The two spans shown in their entirety by the illustration were the ones which fell with the pier. At the time the erection of both spans had been practically completed, and from under one span the falsework had been removed. On the other span the blocking had been removed and the traveler was being taken down, and the men were at work riveting up the floor. This span was, in fact, ready to carry traffic, it being thoroughly bolted up and considerable riveting finished. The design and construction of the piers were fully described in Engineering News of Sept. 15, 1898, and at that time we also expressed the opinion that all the available facts pointed to the pier and not to the spans as the original cause of the accident.

With the purpose of determining the responsibility more definitely, and also of inspecting the wrecking operations, a member of the editorial staff of Engineering News visited the bridge on Oct. 17 and 18, and studied the ground and interviewed all persons likely to possess authentic information upon the accident. The officers of the New York & Ottawa R. R. Co., the owners of the bridge, refused to give any information. In other directions the success of the inquiry was greater, and a number of persons familiar with the structure and competent to judge of the conditions and circumstances gave valuable information. For various personal reasons we are not at liberty to divulge the names of the gentlemen who aided our representative. A careful comparison of the different statements, however, has been made, and the inconsistencies weeded out as far as possible, so that we believe that the following statements are as nearly accurate as the present knowledge of the accident permits.

So far as could be ascertained, no examination was made to determine the character of the bottom of the river previous to the sinking of the cribs for the piers. The only difficulty in making such an examination arose from the swiftness of the current, which ran about five miles per hour at the bridge site. The bottom was successfully examined with a sounding rod in a stronger current, however, after the pier fell. After the cribs were sunk a diver went down inside them and examined the bottom. In the case of the crib which failed, the diver, it is stated, reported that the bottom was hardpan, and brought up a sample to prove his statement. No borings or soundings were made inside the crib to verify further the diver's report or to determine the depth of the hardpan layer.

The whole region surrounding the bridge is clayey. On the Canadian side of the river this clay is hard, but it becomes softer as the American shore is reached. It is, geologically, a glacial drift deposit of clay interspersed in places with deposits of boulders, and a formation which is frequently encountered is a layer of boulders and indurated clay, known locally as hardpan, overlying a deposit of soft blue clay. Such a formation is found in a number of places on the St. Lawrence Power Co.'s canal (Eng. News, Dec. 15, 1898), only a few miles distant.

In erecting the falseworks for the spans it was observed that the bottom was very uncertain. Fig. 2 shows the falseworks in process of erection. It will be noticed that the trestle bents are made up of Phoenix columns braced together by iron rods and timber struts. At the bottoms of these columns were fastened circular shoes or disks 2 ft., and, in some cases, more in diameter. The purpose of these disks was, of course, to give the iron posts greater bearing surfaces on the river bottom, and with a bottom of hardpan such as the piers were supposed to rest on, the size of the disks used was calculated to be ample to prevent any settlement. This did not prove to be the case, however, for, although an extra length was added to the bent posts to allow for settlement, they sunk more than was assumed in several cases. This extra sinking of the bent posts was noticed on both sides and close to the pier which was destroyed.

The destroyed pier was located slightly diagonal to the direction of the current, and had no protection of rip-rap to prevent scour. The ultimate intention was to rip-rap all the piers thoroughly, but this work had not been done. Any scour, therefore, which might be induced by the diagonal position of the pier and the restriction of the channel by the piers and falseworks had an entirely unprotected bottom to act upon.

So much for the conditions previous to the accident. At the time of the accident gas pipe soundings were being made in the Canadian channel of the river by the engineers of the Canadian Department of Railways and Canals, and shortly afterwards the barge being used there was moved around to the American channel and work begun over the site of the destroyed pier. After penetrating about 18 ins. to 2 ft. of hardpan the sounding rod struck a soft clay, into which it was forced from 12 ft. to 18 ft. without difficulty by a man pushing downward on it. The wooden crib had crushed through the shell of hardpan and tipped onto one edge, and the masonry had disappeared. It is surmised that the soft material under the hardpan was a deep pocket formation. Soundings have shown that no such formation exists in the Canadian channel of the river, but, so far as is known, no other soundings of a similar nature have been made in the American channel. It was, however, just such a formation as is found frequently in the surrounding country.

The evidence pointing to the failure of the pier first is both direct and inferential. The survivors of the accident who were at work on the destroyed pier state that it literally sunk from under them. It is difficult to conceive under the conditions how it would be possible for the failure of a member in either of the spans to pull the pier over and destroy all vestiges of it completely. Moreover, the span from which the falsework was removed fell perfectly intact, except for the end

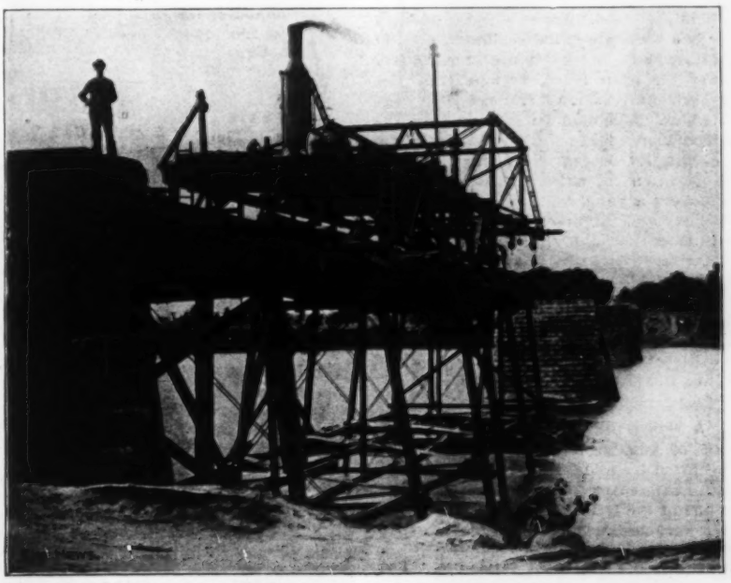


FIG. 2.—VIEW SHOWING CHARACTER OF FALSEWORKS AND TRAVELER USED IN THE ERECTION OF THE CORNWALL BRIDGE.

panel, which rested on fallen pier, according to the examination made by the wrecking company's divers. It pretty certainly did not break in two and drag the pier down. The fact that the pier had shown no signs of failure also agrees in every respect with what one would expect should the pier break suddenly through a shell such as the soundings showed to exist.

As stated above, the second span from the American shore fell into the river intact, and now lies on its side with the upper chord downstream. The shore span, however, carrying the falseworks with it, fell in a tangled mass, occupying the space between the piers. Work was in progress removing the wrecked ironwork at the time our representative made his examination. To take out the wreck of the shore span a winch has been fitted upon the shore pier. The tackle from this is fastened to the wrecked members, which are hauled ashore. Dynamite placed at the connections is employed to break up the wreckage into pieces small enough to be handled. About one-fifth of the wrecked steelwork had been removed on Dec. 15.

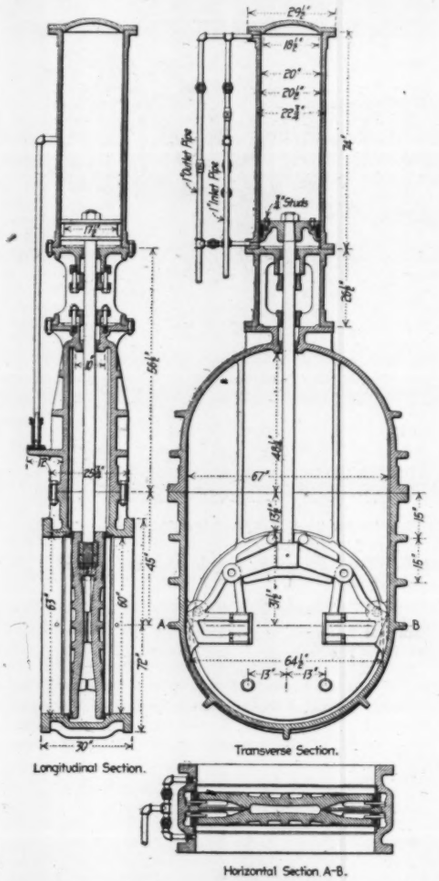
The second span it is proposed to raise as a whole by means of pontoons and thus float it to shallow and quiet water, where it can be broken up. The span is now lying on its side with its top downstream. It is proposed to attach a cigar-shaped pontoon to each of the ten vertical posts. Each pontoon is 8 ft. in diameter and 40 ft. long between its extremities, and has a lifting capacity of 60 tons. Altogether the ten pontoons can thus exert a lift of 600 tons. The fastenings are made by chains between the panel points and the ends of the pontoons, that is, the pontoon lies on top of the span, parallel with the vertical post and the current, with one end chained to the top chord panel point and the other end to the bottom chord panel point. At the time of our representative's visit, work was in progress attaching the pontoons to the wrecked span. Since then the span has been moved downstream about 300 yards and into shallower water, thus forcing the pontoons nearly half their diameter out of water, and consequently destroying their usefulness. The wrecking company has abandoned the work for the winter.

One of the novelties of this work was the working of divers behind shields. With the wreck restricting the channel the current is like a mill race, and it is absolutely impossible for a diver to work in it unprotected. The protection adopted successfully is a steel plate, half-cylinder, 4 ft. in diameter, with a 1 ft. tangent plate at each free edge. Across the open front, between the free edges, are horizontal braces arranged like the rungs of a ladder. This cylinder is hung from the boom of a derrick on a large working barge, and is guyed to ensure its descent vertically into the water. In operation the shield is placed so that its opening covers a panel point, the curved surface being upstream. A diver descending inside the shield is thus thoroughly protected from the force of the current and can attach the chain to the panel point at his convenience. So far as the work had gone at the time of our representative's visit, no accidents had occurred with this shield, and it was doing successfully what it was designed to do. The contractors for the wrecking operations are the Collins Bay Rafting & Towing Co.

## A 60-IN HYDRAULIC VALVE.

In our issue of Aug. 20, 1896, we described a 42-in. valve operated by hydraulic power, a number of which had at that time just been installed on a 42-in. pipe line of the Detroit, Mich., water-works. These valves were designed and built by the Michigan Brass & Iron Works, of Detroit, Mich., and the same firm has recently completed a 60-in. valve of similar design for a water power electric plant at Ft. Ann, N. Y., which we illustrate in the accompanying drawings. These drawings show the nature, arrangement and dimensions of the different parts in detail, and will for that reason be of interest to engineers.

The valve was designed for the flume which conveys the water from the dam to the water wheels in the Ft. Ann, N. Y., electric plant. Here it will be used to shut off the water in case of accident or any other emergency in which prompt shutting off of the water becomes necessary. The pressure employed in testing the valve before shipping it was 75 lbs. per sq. in. Some idea of its size is obtained from the statements that its height is 42 ft., and its total weight is 27,400 lbs. Over 1,500 lbs. of bronze were used in its construction. The several features of construction and operation of the valve are clearly shown by the drawings, and need not be explained further here. For the information from which this description has been




A 60-in. Hydraulically Operated Gate Valve for Water Power Electric Plant at Ft. Ann, N. Y. Michigan Brass & Iron Works, Detroit, Mich., Builders.

prepared we are indebted to Mr. Frank B. Ward, Secretary and General Manager, Michigan Brass & Iron Works, Detroit, Mich.

## STREAM GAGINGS AND OTHER STUDIES RELATING TO IRRIGATION IN WYOMING.*

By Elwood Mead, M. Am. Soc. C. E.†

During the past two years, C. T. Johnston, Assistant Engineer, has given the greater part of his time during each irrigation season to the gaging of streams and looking after the records of their discharges. This work was done for the hydrographic branch of the U. S. Geological Survey, which paid all the expenses, but gave this office copies of the results. In September of this year, Mr. Johnston was employed by the Department of Agriculture in the study of some interstate water right questions in which Wyoming is conecrned. The facts gained in this investigation have also increased our knowledge of the irrigation problems which must in time receive attention from Congress or the courts.

In addition to these measurements, the office made some special investigations into the water supply of several streams, the results of which seem worthy of a place in this report.

Discussions of stream discharges and laws for acquiring rights therein seem to assume that the volume to be divided can be readily ascertained and that all those in charge of the streams have to do is to measure the flow and then apportion it out among users in accordance with their priorities of right. Those who have charge of this division find this conception does not always agree with the facts. Of all the adjudicated streams in Wyoming, I cannot think of one where gagings at one point, no matter what place is selected, will give the volume which can be utilized by irrigators. On many streams irrigators divert the entire flow. Where this is done we are able to locate the sources of that supply and observe its fluctuations to much better advantage than before such diversions were made. In these studies we have found that subterranean waters are of much more importance than was formerly supposed. On some streams springs furnish the main supply; on others, crevices in the rocks are the cause of large losses. Among the adjudicated streams of this state, very few are like canals simply a channel to transport what is turned in at the head. On the contrary, they gain and lose in every mile of their channel. The inclination of the underlying strata often has more influence on a creek's flow than the area of its mountain watershed. Some streams have a large volume where their channels cuts across a rock ledge, while in sandy basins above and below the visible supply will wholly or in large part disappear. Because of these fluctuations the location of a right is often of more importance than the number of its priority. In order to conserve the water supply and secure the most effective division of a creek or river, these changes in the available volume have to be taken into account. They cannot be obtained from a gaging record secured at a single station. What is needed is a careful study of physical conditions along the entire stream.

The experience of our water commissioners would furnish as many illustrations of the truth of these statements as there are rivers to divide. Only a few can be given. We will begin with Salt River, which waters about as many acres of land as any stream in the state, and where the enforcing of rights is about as perplexing as can be imagined. Where this river leaves the mountains it has a perennial flow; so it has at the narrows, 25 miles below; midway between these two points it goes dry every summer. The closing down of every ditch on the main stream and all its tributaries above this dry section would not furnish water to appropriators along it. When I crossed it near Fairview several years ago its channel was as dry as the streets of Cheyenne, while 11 miles below the river was larger than North Platte on the same date.

The North Platte is another, but less striking example. For many years a gaging station has been maintained at Orin Junction. It is an excellent location, and the record is of value in view of possible interstate complications, as the station is below all ditches of any size in Wyoming, and the flow measured gives a close approximation of the surplus which remains for irrigators below. The volume taken out in Wyoming below the station is less than is received from Laramie River, so that when there is a 1,000 sec.-ft. in the river, at the station there should be as much or more for Nebraska's irrigators at the state line. The facts are otherwise. Last july, when 900 sec.-ft. was flowing past the gage rod at Orin, a hot and thirsty representative of Nebraska's irrigators protested against the stream being dried up by Wyoming ditches. He was correct about the river being dry. I crossed it on the Burlington Railroad, near Grand Island, and nothing but a succession of pools was left of the torrent which at that minute raged through the canyon 50 miles west of the Wyoming state line. The water was gone, but it did not depart in ditches. It disappeared in the sand through which the stream winds its devious way. In September the discharge at the gaging station was about 500 sec.-ft. Not 100 sec.-ft. of this was taken out between that point and the eastern border of the state, and the volume diverted was offset by what the Laramie supplied, yet, before the border of Nebraska was reached the water had all disappeared. The channel was nearly dry at the state line. In less than 100 miles over 400 sec.-ft. had gone into the air by evaporation or sunk into the sand by percolation. If, instead of one station on the river, there had been three, one at the Colorado-Wyoming boundary where the river enters the state, another at the Nebraska-Wyoming border where it leaves, and the one at Orin where its present diversion now practically ends, the three records would have little resemblance to each other, while their differences would have no relation to the use of water by irrigators. The loss of over 400 sec.-ft. between Orin and the state line really occurs in half that distance. Gagings made at Fairbanks, 50 miles nearer Nebraska, show a greater discharge than at Orin. The causes of the fluctuations are not at all obscure. Less than a mile below Orin the river cuts across a rock ledge which brings the underflow to the surface. This permits nearly, but not all to be measured. At Fairbanks, a vertical marble dike cuts across the valley. Every particle of water which gets past this has to flow through the narrow notch which the river has eroded. Whatever underflow escapes at Orin is in evidence here. At the state line the river has a broad, shallow bed winding in and out among islands and sand bars, where every condition favors its rapid absorption both above and below.

The report of Mr. Gilcrest shows that the streams, on which he surveyed the ditches in 1897, are divided into sections which are, to a large measure, independent of

*Extracted by permission from the forthcoming annual report of the author, as State Engineer of Wyoming.
†State Engineer, Cheyenne, Wyo.

each other, so far as the enforcement of prior rights or the use of available supply is concerned.

The gaging station at the mouth of the La Prele, maintained by this office in 1897, showed how much water escaped, but it gave no indication of how or where it could have been used to the best advantage.

Horse Shoe, Cottonwood, Chugwater, Lodge Pole, Crow and Lone Tree creeks are examples, in Laramie county, of streams which each year become dry, or almost so, in places, and have a perennial flow in other sections. There is little use in trying to enforce priority of right across some of these dry stretches. The water required to saturate these basins of sand will, if used where it rises, save many acres of crops. The loss of over 400 sec.-ft. in 50 miles of the North Platte is evidence of this. The truth is that each stream is in a measure a law to itself, and conditions along one are no guide as to what they will be on another.

The rise of water in some sections of a stream and its disappearance in others creates some perplexing questions. Many of the earlier ditches were located before these facts were known, and before the extent of the water supply was much thought of. As a result, headgates were placed on sand bars where 10 sec.-ft. has to sink beneath the channel in order to keep one in sight. The loss in putting water into such ditches is, therefore, heavy and other appropriators object to the waste, as they term it, which the enforcement of these rights involves. The members of the Board of Control hold different views regarding our duty in such cases. Some are of the opinion that where the protection of a priority involves an excessive loss, the right should be ignored and the water be given to later appropriators, who can use it to better advantage.

I do not believe we have such discretionary authority. The law gives the first user the better right. It left him free to locate his ditch where he pleased, without regard to the abuses which this absence of direction or control might create. The right cannot, therefore, be disregarded without setting aside the whole theory of prior rights and violating the law creating them. I believe that so long as the law is in force these priorities should be recognized, unless it can be shown that there is not water enough in the stream to supply both the waste and the use combined. If doing this involves a loss to others of such proportions as to make the existence of this right a public injury, the law should be changed. Permanent relief will not come from disregarding statutes, but through their modifications. Let a law be passed to condemn such wasteful rights, other appropriators to pay the costs incurred in proportion to the benefits received.

Influence of Subterranean Waters on the Flow of Streams

In the adjudication of water rights, and in most court decisions affecting those rights, the stream disposed of is treated as though it all had come and was to come from one snow bank, or in other words, as if all the rights established were to be supplied from a single and common source.

Because of this premise it has been held that so long as the supply comes from the same source the place of diversion and use is immaterial, and that the holders of water rights should be permitted to shift their appropriations from one ditch to another and move their priorities up stream or down, as interest or inclination may dictate. Those who uphold this doctrine appear to take it for granted that no matter where the original right was acquired the appropriator took from a supply which included all the water in the stream. The soundness of this doctrine depends, in a large measure, on whether it agrees with the facts. If all the water a stream carries enters above an appropriator's ditch, the claim that the place of diversion is not material has much better foundation than it has where the greater part comes into it below. It has never been held that the beneficial use of water from a particular source gives a right to water from a different one. The first appropriator from Crow Creek cannot transfer his priority to Lodge Pole, and take the water away from the second priority there. Using water from the North Platte gives no right to Green River. So far as streams are concerned, rights are restricted to the source from which originally acquired.

I can think of no reason why such limitation should not apply to rights from a single stream. If it does, then the man who builds a ditch at the head of a creek has no license to move his priority down stream in order to get control of an additional supply which his original ditch could not divert. An irrigator on the Laramie Plains, taking water from the Laramie River, has, in my opinion, no right whatever to Sybille Creek, even if it is a tributary, because it rises on the other side of a range of mountains and joins the river 2,000 ft. below his ditch. To permit the shifting of his priority so that he could take the volume designated in the right out of the river below the mouth of Sybille Creek, would be to recognize control over a stream as foreign to the original appropriation as to transfer the priority to an entirely different watershed.

The experience gained in the division of Wyoming streams has shown that the number in which the rights are based on the entire supply is exceedingly limited. On the contrary, most streams are fed from a multitude of sources, some of which are below many early rights, and hence furnish a supply which was never used by the holders of these rights.

The limit of this report prevents the publication of all the investigations which have led to these conclusions. Like the maps of surveys, we can only present one or two typical examples. The results of the Horse Creek measurements, which follow, could be duplicated by as marked gains or losses on scores of other streams where similar measurements have been made.

The Water Supply of Horse Creek.

Horse Creek rises in the Black Hills, on the western border of Laramie county, and empties into the North Platte near the Wyoming-Nebraska boundary. It is over 100 miles long, but with one exception, all of the ditches now in use are found between the base of the foothills and Hawk Springs, a distance of 70 miles. The adjudicated rights are largely in excess of the stream's discharge, as they aggregate over 1,200 sec.-ft., yet they are derived from a creek whose greatest measured discharge is 32 sec-ft. Practically all the surface supply comes from the mountains at the head. Only two small creeks join it below, and one of these formerly ran dry during the greater part of the irrigation season. The other is overappropriated and nothing but seepage water comes from it. The first ten priorities aggregate 35 sec.-ft. Hence, if the stream was not reinforced except by surface tributaries, these priorities would absorb the largest flow ever measured, and leave irrigators with later rights, amounting to over 1,100 sec. ft., with a lot of paper priorities of little or no value. This is not the existing situation. Certain irrigators, whose priorities are far down the list, have always an ample water supply. Others with early rights have an intermittent and scanty supply. This is not due to the improper division, but to the fact that the ditches are so located that earlier rights just above drain the creek, while farther down, seepage and spring waters reinforce it. Measurements, extending over a period of ten years, have proven that the greater part of the water supply in this stream does not come from the foot-hills, but from the seams in the rock ledges it cuts across. Some of these springs are large—one has a flow of 3 sec.-ft.—but the greater number are so small that they have not been located. In order to show more definitely the extent of this increase, two series of measurements were made this year, the first in May and the last in August. The method pursued was to follow down the stream and wherever a ditch was diverting water the volume taken out was measured, as was the discharge of the stream immediately below the headgate. Adding the two gave the volume above the headgate. These gagings began just outside the foot-hills where the three branches of the creek unite. They ended where Hawk Springs enters the stream over 70 miles below.

The rainfall in May was above the average, and its influence on the first measurements was apparent. While there were no surface streams, the ground was wet and the flow of springs much larger than usual. The August measurement was made during one of the dryest periods of which we have any record. In May the discharge above all ditches was 18.3 sec.-ft.; to this was added the surface flow of Sprager Creek, Little Horse Creek and Hawk Springs, amounting in all to 8.62 sec.-ft. Hence, if none were lost by evaporation in the 70 miles, the total surface supply would be 26.9 sec.-ft. There was taken out over 85 sec.-ft., and the last measurement showed 17 sec.-ft. still in the stream, an apparent loss of less than 10 sec.-ft. for evaporation in the creek channel, and in the use of 85.6 sec.-ft. in irrigation.

When the August measurements were made the irrigation of grain and pastures had ended and some of the ditches in use in May were dry. The first four ditches measured in May were in this condition. While there was a decided shrinkage in the amounts of all measurements, except the seepage from Sprager and Little Horse creeks, the relative importance of the subterranean supplies added to the stream was not diminished.

The amount of water above all ditches was less than 6 sec.-ft. That was the limit of the common supply. Whatever was added below could not be diverted or used by the upper ditches; 17.47 sec.-ft. of seepage and spring water was so added and 4.44 sec.-ft. entered from the two tributary creeks. In both measurements about four times as much water was taken out as there was in the stream at the start, and in both cases approximately as much remained at the end as there was at the beginning.

The subterranean increase comes from two sources. The winter snow and spring rains fill the cavities of the rocks and this finds its way slowly into the creek channel where it cuts through these ledges. The increase between the 10 and 40-mile points is largely from this source. For 15 miles of this distance the creek flows through a canyon with no ditches and no seepage from irrigation. That water from irrigated fields formed a considerable part of the August increase was shown by the fact that the volume of seepage water flowing out of the two tributary creeks showed no material diminution. There is also reason to believe that there has been a progressive increase in the amount of irrigation water which returns, as a comparison with similar measurements described in the report for 1889 shows a considerably larger percentage of increase.

This progressive increase in the water which returns from irrigated fields has been clearly shown on Horse Shoe Creek. For ten years after ditch building began no land was irrigated for two or three miles above the mouth of the stream, although the land was fertile and ditch building easy. Ditches above drained the channel; newcomers were afraid to settle below them. They went higher up stream to get nearer the original supply in an effort to make position offset priority. But when the upper part of the creek had become unquestionably overappropriated springs began to appear near its mouth. While the upper ditches were being closed down to protect early rights water was going to waste at the mouth of the creek. One ditch was built to use it. Later a second ditch was built and the farms under them although last in priority have all the water needed.

On some streams the volume of return or seepage water is small and does not seem to increase. This appears to be due to the underlying strata being inclined away from the channel instead of toward it. Spring Creek, a tributary of the Platte, is an instance.

This office is frequently requested to approve changes in the place of diversion and use of appropriations. The holders of early rights, which experience has shown to have little value, desire to move them to some other point on the stream where from the influence of seepage or other causes, the supply is more abundant. In some cases the request comes from a speculator who sees in these early paper rights a chance to blackmail later appropriators whose ditches are located where the supply is more abundant. I have refused every such request and have notified every one that until either the legislature or courts make the right to move a priority absolute I shall do all in my power to prevent such transfers and to avoid our repeating the blunder made by some of the other arid states. In my opinion this office can do the irrigators of the state no greater service than to prevent the abuses which in all countries have followed the recognition of such right.

I can seen no more reason for permitting an early appropriator near the head of Horse Creek to move his priority down the stream to get the benefit of the springs which he never used than there would be to sanction the transfer of his priority to the Laramie. In both cases it would enhance the value of the migratory right, but it would rob some other appropriator and unsettle and demoralize our whole irrigation system.

## TEST OF AN ALLIS PUMPING ENGINE AT ST. PAUL, MINN.

A new triple-expansion, high-duty pumping engine of 10,000,000 gallons daily capacity, built for the Water Commissioners of St. Paul, Minn., and erected at the McCarron Lake pumping station in that city, has recently been given a 72-hour test, with very satisfactory results.

The test was started at 7 p. m., on Nov. 13, and concluded at 7 p. m., Nov. 16. All the steam used by the engine was condensed and weighed, and the condensation from the jackets was collected and weighed separately. The water delivered was measured by a weir situated at the reservoir, and readings of this weir were taken at frequent intervals. The water pressure was read by means of a mercury gage.

The engine was built by the E. P. Allis Co., of Milwaukee, Wis., and was completed some months before the foundations were ready for its erection. Under the contract, the builders were to receive a bonus of $600 for every million ft.-lbs. of duty secured above 130,000,000 ft.-lbs., up to $6,000, and the tests show that they are entitled to the maximum amount of the bonus. The test was made by Robert W. Hunt & Co., of Chicago, to which firm we are indebted for a copy of the preliminary report, and for the following statement of the dimensions of the engine and the result of the test:

| | |
|---|---|
| Diameter of h.-p. cylinder | 21½ ins. |
| " l.-p. " | 38 " |
| " l.-p. " | 56 " |
| Diameter of plungers | 24¾ " |
| Stroke of pistons and plungers | 42 " |
| Plunger displacement, per revolution | 262.42 U.S. galls. |
| Average: Steam pressure by gage (corrected) | 127.9 lbs. |
| First receiver pressure by gage | 31.8 " |
| Second receiver pressure by gage | 28 " |
| Vacuum by gage | 12.83 " |
| Discharge head on pumps | 146.638 ft. |
| Suction | .052 " |
| Total head on pumps | 146.586 " |
| Total revolutions of engine | 116,649 |
| Average revolutions per minute | 27 |
| Actual total water pumped during test, weir measurement | 254,308,222.97 lbs. |
| Actual water pumped for 24 hours | 10,150,000 galls. |
| Loss by slip and leakage | 0.44% |
| Total condensed steam | 219,601.5 lbs. |
| " jacket steam | 38,443.5 " |
| " dry steam supplied to engine | 258,045 " |
| Duty per 1,000 lbs. steam | 144,463,000 ft.-lbs. |

The engine is of the vertical, triple-expansion, crank and fly-wheel type, the arrangement being somewhat similar to the ordinary type of marine engine. There are three steam cylinders (high, intermediate and low pressure), 21½, 38 and 56

ins. diameter, and 42 ins. stroke. Each steam piston rod connects to a steel cross-head, from which four steel-tie rods extend to the head of the pump plungers, making a direct and rigid connection between the steam pistons and water plungers. The main shaft has three cranks set at angles of 120°, giving a steady turning effect, and as the pump plungers move in unison with the cranks, a very steady flow of water is obtained, and the shock on the pumps and pipes is reduced to a minimum.

The steam cylinders are steam-jacketed, thoroughly covered with a non-conducting material, and lagged with sheet steel. The valve gear is of the Reynolds-Corliss type, the high pressure gear being under the control of an adjustable speed regulator, while the intermediate and low pressure cylinders are adjusted by hand. The steam and exhaust valves are located in the cylinder heads, reducing the clearance to a minimum (2% in the high-pressure cylinder, 1.6% in the intermediate, and 1.37% in the low pressure).

The pumps are located below the engine bed plates, and are of the single-acting, outside-packed, plunger type, provided with large valve area, the valves being of rubber and arranged in groups mounted on "cages." The valve chambers support one end of the engine bed plates, this arrangement reducing the amount of foundation required, while at the same time it renders the pumps more accessible. The opposite end of the bed plates is carried on a masonry pier.

A surface condenser is located in the suction pipe. The air and feed pumps are driven direct from the main engine by means of an arm on the low pressure plunger. The throttle valve, injection valve for condenser, cut-off levers, etc., are all so placed that the engine can be stopped, started and controlled from one position on the engine-room floor. The total weight of the engine is 200 tons.

The engine has a capacity of 10,000,000 gallons in 24 hours, when operated at a plunger speed of 189 ft. per minute (27 revolutions). The pump HP. during the test was 262.47; with 279.56 I. HP., the friction being 6.11%. The steam consumption was 12.82 lbs. per I. HP., the steam pressure being 127.9 lbs.

During the test steam was applied by two horizontal tubular boilers, each 5½ ft. diameter and 18 ft. long, but as the duty test was on steam, no effort was made to obtain high boiler efficiency. In fact, the builders state that the conditions were poor for high boiler efficiency, the actual evaporation being only about 7.57 lbs., while under ordinary conditions the boilers readily evaporate 8.5 lbs.

## TESTS OF A DIESEL MOTOR.

We have received from the Diesel Motor Co., of America, 11 Broadway, New York city, a pamphlet containing a report by Prof. James E. Denton, of the Stevens Institute of Technology, of the principal results of a series of economy tests of a Diesel motor, rated at 20 brake HP., using various kinds of oil as fuel. The motor is one of the first made for the market in Germany, and is the first that has been brought to this country. It was erected at the Electrical Exhibition held last spring in New York city, where it drove an electric light plant for five weeks. It was then erected for the purpose of the tests at No. 24 West St., New York city. The results confirm those obtained from similar engines in Germany, and are worthy of record as marking a long step forward in the economy of oil engines. We give a condensation of Prof. Denton's report below:

### Description of Motor.

The motor has one main cylinder 10.23 ins. diameter and 16.16-in. stroke. The piston, which is exposed to the atmosphere on its under side drives the main crank by direct connection, and an air-compressing pump, about 3.5 ins. diameter and 8.05-in. stroke, through a lever. Two poppet valves in the main cylinder head control the introduction of air from the atmosphere to the main cylinder and the exit of the contents of the main cylinder during exhaust. A smaller poppet valve introduces fuel, which is fed from an oil tank by a small pump. A fourth poppet valve controls the introduction of air from the air receiver for the purpose of starting the motor. The operation is as follows:

The receiver is charged with air at the desired maximum pressure (about 600 lbs. per sq. in.). To start the engine the piston is placed at the top of its stroke. A hand-starting lever is set so that all the cams upon the valve shaft are inoperative except the one connected to the starting valve, which then holds the latter open. The oil pump is operated a few strokes by hand, whereby the space around the stem of the starting valve is supplied with oil. On opening a cock by hand, the pressure from the receiver acts upon the piston and starts the latter downward. At the end of the down-stroke the rotation of the cam shaft has automatically closed the starting valve, and put the three operating valves into regular action. The momentum acquired in the down-stroke carries the piston through an up-stroke, and compresses the contents of the main cylinder to about 520 lbs. per sq. in., whereby they are heated to a temperature of upwards of 1,000°F. As the piston starts to make another down-stroke by momentum, the fuel valve opens, and the 600 lbs. of air pressure in the receiver acting upon the fuel forces it into the heated contents of the cylinder, thereby causing combustion to occur, and power to be developed throughout the second down-stroke, the fuel valve closing at about one-tenth of the stroke of the piston, so that the heat developed is applied with a high degree of expansion. On the next up-stroke the exhaust valve is opened, permitting the cylinder to exhaust itself against the atmosphere. During the next down-stroke of the piston the inlet valve connecting with the atmosphere, supplies the cylinder with pure air. This is compressed on the return stroke, and oil again introduced, and thence the operation of the engine proceeds regularly.

The pistons of the main and air cylinders are lubricated automatically from a reservoir.

The revolutions of the engine are governed by a fly-ball governor, which controls the effective length of the stroke of the oil-feeding pump.

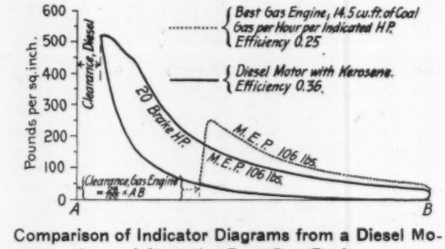
The engine was provided with a fly-wheel, 6¼ ft. diameter, weighing about 2,800 lbs. Its total weight, including fly-wheel, was about 600 lbs. per rated brake HP., which is about 70 lbs. greater than that of a Priestman oil engine, of 7 brake HP., running 208 revolutions per minute.

The distinctive thermodynamic features of the engine compared with existing explosive gas and oil engines are:

1. That the cylinder contents during compression consist of air only, so that the compression may cause a pressure at the end of the in-stroke far above that which would cause premature explosion in a gas engine, or explosive oil engine.

2. The greater degree of compression confines the contents of the cylinder when combustion occurs to about 0.07 of the cylinder volume, whereas in explosive gas or oil engines they occupy about 0.28 of that volume. (See cut.) Consequently in the Diesel motor the available rate of expansion of the heated contents of the cylinder is several times as great as that of the gas and oil motors, and, therefore, the theoretical proportion of the heat of combustion utilized in work upon the piston is about 20, 25 and 36%, respectively, for the best explosive oil engine, gas engine, and Diesel motor.

3. The fuel in the Diesel motor burns gradually in the cylinder, during the first one-tenth of the stroke (as does oil which is burned under a steam boiler), without augmenting the pressure above that due to the compression of the contents of the main cylinder by its piston. Consequently the particular proportion of air to fuel necessary to secure explosion is unnecessary. The proportion of air to fuel may be anything, provided there is air in excess of that required for combustion. The proportions of this engine permit the excess to be about 25% at full load, and the presence of this excess of air ensures the steady maintenance of perfect combustion, which, together with the relatively small clearance space as compared to that of explosive engines (see cut), protects the engine against unreliable acting from fouling of the cylinder under continued action.




Comparison of Indicator Diagrams from a Diesel Motor and from the Best Gas Engine.

### Results of Experiments.

Tests were made with ordinary domestic kerosene, and with the various grades of petroleum used as fuel under steam boilers, which covered the operation of the engine for upward of 250 hours, to observe the behavior of the oil, and the conditions of the interior of the engine after using each oil. During this time economy tests were made of from 1 to 10 hours' duration, as per the data in Table I. The principal commercial results abstracted from this table are as follows:

TESTS OF THE DIESEL MOTOR.—By Prof. J. E. Denton, M. Am. Soc. M. E.

| Kind of oil used | Ordinary Domestic Kerosene. | | | | | | Fuel Oil. | | | | Eagle Crude Oil. | | | | Lima Crude Oil. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 19 HP. | 21 HP. | 15 HP. | 13 HP. | 9 HP. | | 20 HP. | 13 HP. | 11 HP. | No load. | 21 HP. | 11 HP. | No load. | | 21 HP. | 15 HP. | 11 HP. | No load. |
| Approximate brake horse-power | Jan. 30. | July 1. | July 9. | July 8. | July 8. | | July 29. | July 29. | July 29. | July 29. | Aug. 27. | Aug. 27. | Aug. 27. | | Aug. 27. | Aug. 29. | Aug. 27. | Aug. 27. |
| Date of test | 2.00 | 1.996 | 2.00 | 1.50 | 1.50 | | 1.94 | 2.07 | 0.81 | | 0.76 | 1.00 | 0.49 | | 0.96 | 1.00 | 1.01 | 0.50 |
| Duration, hours | 636.6 | 631.7 | 643.7 | 611.7 | 621.8 | 618.9 | 630.1 | 617.4 | 623.0 | | 651.7 | 643.1 | 620.4 § | | 634.6 | 653.1 | 650.2 | 632.5 |
| Pressure in air tank, lbs. per sq. in. | 740.+ | 740.+ | 740.+ | 673. | 673.+ | 673.+ | 674.+ | 674.+ | 674.+ | | 740.+ | 740.+ | 740.+ | | 740.+ | 628.3 | 628.3 | |
| Temperature of exhaust gases, °F. | 73.0 | 110.2 | 119.9 | 78.0 | 78.0 | 78.0 | 74.6 | 74.6 | 74.6 | | 76. | 76. | 76. | | 75.6 | 75.6 | 75.7 | 76. |
| Inlet cooling water, °F. | 74.0 | 76.1 | 76.0 | 76.0 | 76.0 | 76.0 | 74.6 | 74.6 | 74.6 | | 74. | 74. | 74. | | 74. | 126.2 | 126. | 119. |
| Outlet cooling water, °F. | 110.6 | 119.9 | 106.6 | 128.0 | 120.6 | 113.6 | 98.2 | 98.2 | 96.2 | | 127. | 123.9 | 116.5 | | 115.7 | 115.7 | 111.87 | 87.55 |
| M. E. P. of main cylinder, lbs. per sq. in. | 103.900 | 108.462 | 87.612 | 81.197 | 66.763 | 46.20 | 116.67 | 108.98 | 69.20 | | 110.43 | 76.14 | 76.58 | | 76.15 | 111.87 | 83.81 | 53.86 |
| M. E. P. of air cylinder, lbs. per sq. in. | 60.00 | 61.71 | 64.89 | 63.48 | 63.4 | 63.4 | 67.86 | 67.86 | 67.86 | | 76.25 | 76.25 | 76.25 | | 79.78 | 79.78 | 79.78 | 79.78 |
| Max. indicated press., main cyl'dr, lbs. pr. sq. in. | 520.63 | 521.57 | 521.08 | 517.45 | 510.02 | 505.5 | 522.1 | 515.4 | 511.4 | | 542.4 | 542.4 | 542.4 | | 549.0 | 537.1 | 533.7 | 526.9 |
| Max. pistonfloss, per minute | 187.6 | 186.6 | 186.8 | 191.5 | 186.5 | 188.5 | 184.2 | 185.7 | 187.9 | | 186.9 | 183.65 | 180.7 | | 182.4 | 184.2 | 184.4 | 190.1 |
| I. HP. of main cylinder | 31.33 | 32.53 | 33.99 | 28.14 | 25.40 | 21.11 | 32.34 | 24.49 | 12.51 | | 31.32 | 22.03 | 23.85 | | 34.02 | 23.85 | 25.11 | 14.04 | |
| Of air cylinder | 2.01 | 2.06 | 2.22 | 2.145 | 2.17 | 2.25 | 2.27 | 2.22 | 2.22 | | 3.09 | 3.10 | 3.19 | | 3.13 | 3.32 | 3.19 | 3.32 | |
| Net | 29.32 | 30.46 | 31.83 | 25.92 | 23.255 | 18.94 | 30.07 | 22.24 | 10.29 | | 28.22 | 19.54 | 20.53 | | 30.89 | 20.53 | 21.62 | 10.52 | |
| Brake HP. | 19.43 | 20.81 | 21.61 | 15.16 | 13.05 | 8.78 | 20.07 | 12.56 | | | 19.64 | 11.44 | 10.58 | | 20.76 | 10.58 | 20.73 | 15.16 | 10.77 | 10.52 |
| Friction HP. | 9.89 | 9.65 | 10.22 | 10.76 | 10.205 | 10.16 | 10.00 | 9.68 | 10.29 | | 9.55 | 8.15 | 9.95 | | 10.14 | 9.95 | 10.89 | 8.83 | 10.10 | |
| Mechanical efficiency, % | 66.246 | 68.32 | 67.37 | 58.49 | 56.12 | 46.36 | 66.74 | 56.47 | | | 67.28 | 71.12 | 58.55 | | 67.17 | 51.54 | 65.56 | 63.20 | 51.61 | 10.52 |
| Oil consumption: Per hr., per B. HP. { Lbs. | 0.549 | 0.534 | 0.549 | 0.594 | 0.586 | 0.721 | 0.613 | 0.668 | 0.681 | | 0.626 | 0.688 | 0.555 | | 0.691 | | | | 0.672 | |
| { U. S. gal. | 0.0835 | 0.0839 | 0.0846 | 0.0896 | 0.0886 | 0.1102 | 0.0862 | 0.1068 | 0.1044 | | 0.0975 | 0.0887 | 0.0778 | | 0.0978 | 0.520 | 0.579 | | 0.672 | |
| Per hour per net I. HP. { Lbs. | 0.36 | 0.365 | 0.367 | 0.329 | 0.324 | 0.409 | 0.463 | 0.427 | 0.445 | 0.409 | 0.373 | 0.356 | 0.520 | | 0.0784 | 0.0826 | 0.0811 | 0.0941 | | |
| { U. S. gal. | 0.0558 | 0.0566 | 0.0561 | 0.0493 | 0.0611 | 0.0575 | 0.0540 | 0.0656 | 0.0630 | 0.0679 | 0.0527 | 0.0503 | 0.0734 | | 0.0542 | 0.0513 | 0.0488 | 0.0682 | | |
| Efficiency on brake HP., % | 25.20 | 25.77 | 25.06 | 23.17 | 23.468 | 19.00 | 29.68 | 22.03 | | | 28.22 | 19.54 | 20.53 | | 30.89 | 20.53 | 21.62 | 24.57 | 15.52 | |
| Efficiency on net I. HP., % | 38.01 | 37.70 | 39.66 | 41.83 | 41.20 | | | | | | | | | | | | | 14.04 | 10.52 | |
| Cooling water, per hr., per brake HP., lbs. | | | 82.4 | 126.8 | | 117.8 | 99.1 | 154.3 | | | 101.7 | 90.8 | 170.4 | | 59.0 | 88.8 | 86.0 | 71.6 | 91.9 | |
| Heat units abstracted pr hr. pr B.HP. B.T.U. | | | 3,617 | 4,007 | | | 3,914 | 4,629 | | | 4,322 | 3,768 | 6,921 | | 4,481 | 3,175 | 3,580 | 3,623 | | |
| Quality of oil: Calorific value,† B.T.U., per lb. | | | | 20,156 | | | | 19,080 | | | | 19,742 | | | | | | 19,643 | 19,537 | 2,761 |
| Flash test, °F. | | | | 18,694 | | | | | | | | | | | | | | | | |
| Fire test, °F. | | | | 150 | | | | 200 | | | | 249 | | | | | | 190 | | |
| Specific gravity at 60° F. | | | | 0.784 | | | | 0.852 | | | | 0.846 | | | | | | 0.868 | | |

†Mahler's bomb. §Corrected for condensed vapor, B. T. U., per lb.

1. With ordinary colorless domestic kerosene, of 120°F. flash, 150°F. fire test, and 0.784 gravity, at about 187 revolutions per minute, an average of 20.8 brake HP. was developed, with an oil consumption of 0.534 lbs., or 0.082

U. S. gallon per hour per B. HP.; 13.05 B. HP. with an oil consumption of 0.586 lbs., or 0.0896 U. S. gallon per hour per B. HP., and 8.78 B. HP. with an oil consumption of 0.72 lbs., or 0.110 U. S. gallon per hour per B. HP. This shows an efficiency on B. HP. of 25.8, 23.5 and 19.0% respectively. The corresponding indicated horse-power efficiencies were 37.7, 41.8 and 41.2% respectively. These results practically confirm the tests made on an engine rated at 19 B. HP., at Augsburg, Germany, by Professor Schroeter and other experimenters, which for 17.33 English HP. showed an oil consumption of 0.54-lb., or 0.0819 U. S. gallon of American kerosene per hour per B. HP., and for 9.315 English HP. an oil consumption of 0.63 lb., or 0.0956 U. S. gallon per hour per B. HP., the efficiencies being as follows.

| | Per cent. on 17.33 HP. | Per cent. on 9.315 HP. |
|---|---|---|
| Thermal efficiency on indicated HP... | 34.15 | 38.18 |
| Thermal efficiency on brake HP..... | 25.81 | 22.12 |

The same increase in indicated efficiency with reduction of load to one-half, shown by the German tests, is found in the New York tests. The mechanical efficiency, or the per cent. of the indicated power utilized at the brake, of the New York motor was not as great as that of the motor tested in Germany—a result which is possibly attributable to the insufficiency of the foundation of the New York motor, which by permitting excessive vibration, may have caused a waste of power between the cylinder and the brake. The New York motor showed the greater indicated efficiency, however, which is probably due partly to the slight difference of maximum pressure, and partly to the higher temperature of cooling water reducing the jacket waste.

The heat balance for the two cases is as follows:

Heat Balance.

| | Brake HP. 21.51 | 8.78 | 17.33 | 9.315 |
|---|---|---|---|---|
| | New York. | | Augsburg. | |
| Heat* ..... | 37.2% | 41.2% | 34.7% | 38.9% |
| Removed by jacket ..... | 35.4% | 37.4% | 40.3% | 45.1% |
| Remainder ..... | 27.4% | 21.4% | 25.0% | 16.0% |
| Total heat of combustion. | 100.0% | 100.0% | 100.0% | 100.0% |

Examination of the interior of the engine during the use of the kerosene showed that there was no deposit on the surfaces, other than an infinitesimally thin film of lampblack on the cylinder and piston head, which did not increase with time. The bore of the cylinder was clean and polished.

2. With Pratt's fuel oil, which is a dark, straw-colored, clear petroleum, of 200°F. flash, 268°F. fire test, and 0.852 gravity, considerably used as a steam-boiler fuel, at practically the same revolutions, 20.07 B. HP. were developed with an oil consumption of 0.613-lb., or 0.0862 U. S. gallon per hour per B. HP.; and 12.56 B. HP. with an oil consumption of 0.681-lb., or 0.0958 U. S. gallon, per hour per B. HP. The operation with this oil was attended with the same insignificant lampblack deposit.

3. With a black, clear, Pennsylvania petroleum, known as "Eagle" fuel oil, of 249°F. flash, 296°F. fire test, and 0.849 gravity, at practically the same speed, 20.75 B. HP. were developed with an oil consumption of 0.56-lb., or 0.0784 U. S. gallon, per hour per B. HP. This oil left absolutely no deposit in the cylinder.

4. With Lima fuel oil, a black, clear petroleum of 0.856 gravity, at about the same speed, 20.73 B. HP. were developed with an oil consumption of 0.59-lb., or 0.0826 U. S. gallon, per hour per B. HP.; and 10.77 B. HP. with an oil consumption of 0.672-lb., or 0.0941 U. S. gallon, per hour per B. HP. The operation with this oil was attended with no deposit in the cylinder whatever.

5. With California crude oil, a black, clear petroleum of 0.846 gravity, with practically the same revolutions, 20.07 B. HP. were developed with an oil consumption of 0.626-lb., or 0.0887 U. S. gallon, per hour per B. HP., and 11.44 B. HP. with an oil consumption of 0.699-lb., or 0.099 U. S. gallon, per hour per B. HP. This oil left absolutely no deposit in the cylinder.

With all these oils the engines started instantaneously and operated very steadily. The action of the valve gear is very smooth, and practically noiseless. The combustion occurred with perfect regularity, and was accompanied with no noise other than that due to the pulsation of the floor under the engine. There was also no noise from the exhaust of the engine audible a few feet distant from the chimney into which the exhaust pipe led.

The exhaust gases with all of the oils carried no soot, a piece of white paper being unsoiled by the impingement of the gases against its surface.

No deposit was found in a drum, forming part of the exhaust pipe, after the entire 250 hours of operation of the motor.

The cooling water is shown in Table I. to be 60 lbs. per B. HP., with an outflow temperature of 127°F. The engine operates safely, however, with water leaving the jacket at 140°F., which would reduce the water to about 50 lbs., or 6 gallons per hour per B. HP. The quantity of water used does not, however, constitute an expense item in the use of the motor, as it can be stored in an inexpensive reservoir, or cooling tower, which once charged, will last indefinitely.

The cost of operation will then be practically confined to the cost of oil, and as the motor shows itself to be able to use oil obtainable at about 2 cts. per gallon, the cost of a B. HP. may be 0.2-ct. per hour, which is slightly less than the cost of the same power from the average triple-expansion steam engine, with coal at $3 per gross ton.

*Heat of combustion accounted for by indicated power.

## THE CONTRACT FOR THE COOLGARDIE STEEL PIPE LINE, WESTERN AUSTRALIA.

During the current year we have given considerable space to accounts of the immense steel pipe line, 30 ins. in diameter and 328 miles long, to be built by the government of Western Australia to supply water to the Coolgardie mining district.*

Through the courtesy of Mr. C. Y. O'Connor, M. Inst. C. E., of Perth, W. A., Engineer-in-Chief of the Department of Public Works of Western Australia, we are enabled to give further particulars regarding the contract and the pipe to be used in its fulfillment.

As stated in previous issues, the works as a whole include, besides the pipe line, a large storage reservoir, nine pumping stations, and a small intake reservoir at each station. The works are designed to deliver 5,000,000 (British?) gallons a day, with an aggregate lift of 1,313 ft. at the nine stations, the lifts generally being through short sections of the line, with long sections of falling grade between them.

As coal costs some $7 to $8 a ton and the total lift is so great, it is of course desirable to reduce friction to a minimum, even at a large increase in the capital outlay for the pipe line. Mr O'Connor originally planned to use 30-in. spiral riveted pipe for the whole line, but the English engineers recommended 26, 27½ and 29-in. pipe, according to the head, and that pipe of plates ¼-in. or more in thickness be made with two gas-welded longitudinal joints; and that the pipe made of 3-16-in. plates, comprising about 246 of the 330 miles, be riveted longitudinally and transversely, with sections alternately in and out. The contract as finally awarded is for pipe of a diameter of 30 ins. throughout, in 28-ft. sections, with two longitudinal locking bar joints. For the transverse joint, steel rings, or sleeves, calked with lead, will probably be used, to be furnished by the contractors at the option of the government.

Bids for furnishing the pipe f. o. b. in Western Australia, including all duties, insurance and freight, were invited at London, and also at Perth, W. A. The lowest bids received in London were, for the riveted pipe, $3,810,000, from Buchner Blagen, of Portland, Ore.;** for the welded pipe, $2,300,000, from Piggot & Co.; total, $6,100,000. The lowest bids at Perth were, for the riveted pipe, $3,325,000, from G. & C. Hoskins, of Sydney; for locking bar pipe, in lieu of welded, $1,165,000, from Mephan Fergusson, of Perth; total, $4,490,000. The engineer's estimate for 330 miles of 30-in. spiral riveted steel pipe was $5,340,000, so the lowest home bid was not only lower than the foreign bid, but lower than the estimate by $850,000. If, however, the lowest bid for welded pipe, which type was specified, had been accepted, the aggregate of the lowest bids would have been $5,625,000, or $285,000 above the estimate, the smaller size of the welded pipe not making up for its increased cost.

After negotiations with the lowest home bidders, Messrs. Hoskins and Fergusson, it was finally arranged, and a contract executed accordingly, that the contract should be divided equally between them, the size of all the pipe to be increased to a diameter of 30 ins., and the thickness of the 3-16-in. plates, making up a large part of the contract, to be increased to ¼-in. Of the 61,856 lengths of 28-ft. pipe, 1,000 will be made from 5-16-in. plates, and the balance from ¼-in. The contractors, of course, revised their unit prices, and as the quantities were increased the aggregate of the new bids was brought up to $4,990,000, which is still $350,000 below the engineer's estimate. The contract also includes as many steel jointing rings, up to 61,856, as the government may desire, at about $5.50 each. This item was made conditional, owing to doubts as to whether these rings can be used for all joints. The original intention was to lay the pipe on the surface of the ground, but this has been abandoned, rendering unnecessary the expansion joints illustrated in our issue of Oct. 13.

The weight of the steel involved in this pipe contract, without the rings, is 74,442 long tons. The coating will add 3,867 long tons. The contract price for the coated pipe is about $65.30 per long ton, or a little under 3 cts. per lb., f. o. b. at Falkirk, W. A. The contract is dated Oct. 18, 1898. The specifications for the pipe are as follows, being identical for each of the two contracts:

(1) Quantities and Dimensions—
30,428 lengths of 28 ft. each ¼-in. thick and 30 ins. internal diameter.
500 lengths of 28 ft. each, 5-16-in. thick and 30 ins. internal diameter.
Total, 30,928 lengths of 28 ft. each.

(1) General Description of Pipes.—The pipes shall be of the type known as Mephan Ferguson's Patent Rivetless or Locking-bar Pipes, and each 28 ft. length of pipe shall be composed of not more than two plates and two longitudinal locking-bars, as shown in the drawings. Each locking-bar of the ¼-in. pipes shall weigh not less than 6½ lbs. per lin. ft., and each locking-bar of the 5-16-in. pipes shall weigh not less than 7⅝ lbs. per. lin. ft., unless it shall have been conclusively proved to the satisfaction of the engineer that such weights can be reduced without any risk of impairing the efficiency of the locking-bar joint, which must in all cases be of the full strength of the plates. If, on the other hand, it be found that the weights specified are too light, or that the sections shown in the drawings are capable of improvement, then the bars shall be increased in weight or be otherwise modified as the engineer may direct.

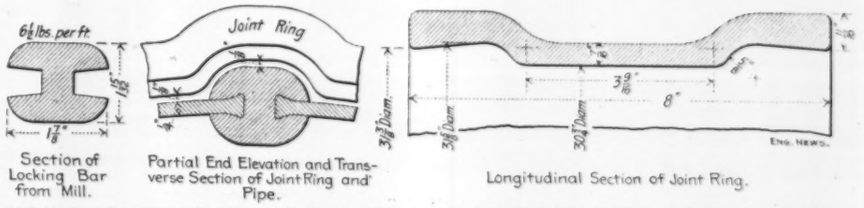
(3) Joint Rings.—The contractor shall also supply so many welded steel joint rings of the type shown in the drawings as may be ordered, up to a total of 30,928 of such rings at the rate of £1 2s. 6d., delivered at Falkirk.

(4) Anchor Plates.—Three feet from one end of every fourth 28-ft. length, three 12-in. pieces of angle iron, 6 × 4 × ⅜-in., shall be double riveted to the pipe to prevent creep, wherever the engineer may consider that such precaution is desirable.

(5) Special Pipes.—Where required, the contractor shall provide, at the same price per foot as ordinary lengths, special lengths to connect pipes of different thicknesses of metal, so that a good joint may be made without fitting or arranging in laying the pipes, and also such tapered tubes as may be required for purposes of fitting valves of all kinds. The contractor shall also supply without extra cost such tubes as may be required for curves, with ends either not parallel to each other or not rectangular to the pipe, as the engineer may direct.

(6) Coolgardie to Kalgoorlie Pipe Main.—The contractor shall also provide, if required, half the quantity of pipes necessary for a water main from Coolgardie to Kalgoorlie at the same rate per ton as his contract price per ton for the pipes of 30 ins. diameter and ¼-in. thick, herein provided for. The diameter of such main has not yet been determined upon.

(7) Quality of Steel.—The plates and bars shall be made of open hearth acid steel and the plates shall be capable of withstanding a tensile strain of not less than 25 tons [N. B.: All tons are long tons here.—Ed.] nor more than 2 tons per sq. in., with elongation in 10 ins. of not less than 20%, and contraction of area of not less than 45%. The steel must also resist the following drifting test, that is to say: A hole ⅝-in. diameter to be punched within 1¼ in. of any edge of a plate and to be drifted out




Section of Locking Bar from Mill.

Partial End Elevation and Transverse Section of Joint Ring and Pipe.

Longitudinal Section of Joint Ring.

DETAILS OF LOCKING BAR AND RING JOINTS FOR THE COOLGARDIE STEEL PIPE LINE.

*See Eng. News, Feb. 10, 1898, for a description of the scheme, and a profile of the pipe line; Feb. 17 and Oct. 13, 1898, for editorial discussions of the pipe line, including the recommendation of the English engineers, who reported on it; and Nov. 17, 1898, for a brief note on the award of the contract.

**But the bid was for basic, instead of acid, steel, and for punched, instead of drilled rivet holes.

cold to a diameter of 1¼ in. without showing signs of fracture. It must also resist such hot and cold bending tests as the engineer may consider necessary to assure him that the steel is of the best quality and perfectly suitable for the work. The manufacturers of all steel employed on the work must be previously approved in writing by the engineer.

(8) Testing of Steel.—Each plate on leaving the rolls shall be stamped with its cast number or with consecutive numbers which will identify the cast. A mill sheet giving cast numbers and size of each plate shall be supplied every morning to the authorized representative of the engineer, who will then select pieces for tests of tensile strength. Not less than two tensile tests will be made from each cast, and bending and drifting tests will be made from each plate, and the pieces must bend cold round a bar of a diameter of three times the thickness of the plate, without signs of fracture. Pieces must be sheared for the purpose of testing and duly marked with the plate number. Should the test pieces fail to withstand any of the specified tests, the whole cast represented will be liable to rejection.

(9) Testing of Locking-Bar.—Sections of locking-bar and adjacent plates, shall be cut from any such pipes as the engineer may direct and such sections shall be submitted to tensile strain for testing the efficiency of the locking-bar joint, which must be capable of withstanding without injury a strain equivalent to 29 tons per sq. in. of plate, unless the plate itself fail within the limits of 25 and 29 tons per sq. in. specified for such plates, but the joint must be always fully as strong as the plate and shall safely resist all strains within the limits above mentioned.

(10) Method of Manufacture.—The pipes shall be made strictly to the drawings and shall be as nearly circular as possible. The thickness of plates specified are those of the thinnest parts of the plates. Every plate will be measured, and all will be rejected in which the thickness of any part falls in the least degree below that specified. The workmanship throughout shall be the best possible.

(11) Calking.—No calking of the locking-bar joint will be permitted.

(12) Protection of Plates and Bars.—All plates and bars which may be imported into the Colony by the contractor shall be carefully protected against oxidisation, and all plates and bars which have become unduly rusted will be rejected, and shall be forthwith removed from the works.

(13) Dipping of Bars and Edges of Plates.—Before the locking-bar joints are made the locking-bars and the outer portions of the plates shall be completely freed from black oxide, by being dipped in a bath of dilute sulphuric acid and then in a bath of limewater, followed by scrubbing if necessary. This must be done under cover, and the plates and bars must not be exposed to the weather after dipping, but must be at once formed into pipes.

(14) Pressure Test.—The pipes shall then be submitted to hydraulic pressure of 400 lbs. to the sq. in., and also to smart tapping with a hammer while under pressure. All pipes which leak, or show other defects, shall be rejected, or the defects remedied in such manner as may be approved by the engineer.

(15) Dipping of Pipes.—After having been tested and approved by the engineer, the pipes shall be dipped in a bath of dilute sulphuric acid and then in a bath of limewater, and shall, when thoroughly clean, be forthwith coated.

(16) Coating.—The pipes shall be coated with a composition, consisting of Trinidad asphaltum and creosote as soon as they have been freed from black oxide, and otherwise thoroughly cleansed, as specified in Clause 15 above. They must be heated uniformly before being immersed to about 300°F., and the bath of composition must be kept fluid at an uniform temperature. They must be left in the asphaltum bath long enough to acquire the same temperature as the bath, and then suspended until the excess of coating has drained off. Very special care must be taken in coating the pipes, and the whole of the arrangements, as well as the composition of the asphaltum mixture, must be to the entire satisfaction of the engineer.

(17) Place of Delivery.—The pipes, special pipes and joint rings, etc., shall be delivered on land belonging to the Government, at Falkirk, Western Australia, and shall, after having been finally passed by the engineer, be stacked on a piece of land belonging to the Government, and reserved for the purpose, so that they may be kept apart from those which have not yet been passed.

(18) Special Pipes Testing and Treatment.—All special pipes provided for in this specification shall be tested and treated in a similar manner to the 28-ft. lengths of pipes.

(19) Joint Rings Testing and Treatment.—The materials of which the joint rings are to be constructed shall, as far as practicable, be subject to similar tests, and shall be treated in a similar manner to the materials of which the pipes are to be constructed.

The designs for the locking-bar for the longitudinal joints and the steel rings for the transverse joints are shown in the accompanying illustration. The only work on which this locking-bar has been used heretofore, so far as we can learn, was for 8¾ miles of 15 and 26-in. pipe connected with the water supply of Adelaide, S. A., as described in our issue of June 9, 1898. Editorial comment on the contract is made elsewhere in this issue.

**WEATHER TABLE FOR NOVEMBER, 1898. (Furnished to Engineering News by the Department of Agriculture.)**

| | Stations. | Temperature. (Degrees Fahrenheit.) Average. | Max. | Min. | Range. | Wind. Velocity in miles per hour. Average. | Max. | Direction at time of max. velocity. | Precipitation—Rain or melted snow. (Inches.) Total. | Heaviest in 24 hours. | No. of rainy days. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Northern Cities. | Northfield, Vt. | 32.4 | 61 | 1 | 60 | 9 6 | 42 | SW | 1.97 | 1.03 | 10 |
| | Portland, Me. | 38.6 | 58 | 18 | 40 | 8.0 | 42 | NE | 5.51 | 1.71 | 13 |
| | New York City | 44.6 | 63 | 25 | 38 | 17.5 | 65 | NW | 5 90 | 1.60 | 12 |
| | Pittsburg, Pa. | 42.7 | 70 | 18 | 52 | 6.4 | 24 | NW | 2.34 | 0.88 | 17 |
| | Chicago, Ill. | 37.0 | 67 | 2 | 65 | 21.2 | 76 | S | 2.25 | 1.70 | 13 |
| | Omaha, Neb. | 35.2 | 76 | — 1 | 77 | 8.6 | 34 | NW | 1.20 | 1.05 | 6 |
| | St. Paul, Minn. | 29.6 | 60 | —10 | 70 | 9.0 | 36 | NW | 1.59 | 0.92 | 8 |
| | Duluth, Minn. | 29.0 | 58 | — 4 | 62 | 11.5 | 56 | NW | 0.94 | 0.56 | 7 |
| | Bismarck, N. Dak. | 24.0 | 58 | —15 | 73 | 9.8 | 48 | NW | 0.16 | 0.06 | 7 |
| | Average | 34.8 | 63 | 4 | 60 | 11.3 | 47 | — | 2.43 | 1.00 | 10 |
| Southern Cities. | Washington, D. C. | 44.0 | 69 | 22 | 47 | 7.2 | 32 | NW | 3.12 | 0.95 | 15 |
| | Louisville, Ky. | 44.7 | 74 | 14 | 60 | 9.1 | 43 | SE | 2.85 | 1.43 | 11 |
| | St. Louis, Mo. | 43.1 | 74 | 10 | 64 | 11.2 | 58 | SW | 2.07 | 1.09 | 8 |
| | Savannah, Ga. | 57.2 | 79 | 31 | 48 | 8.8 | 31 | NW | 6.28 | 4.15 | 11 |
| | Kansas City, Mo. | 40 3 | 73 | 6 | 67 | 9.0 | 39 | SE | 2.72 | 1.54 | 9 |
| | Jacksonville, Fla. | 62.6 | 81 | 36 | 45 | 7.5 | 30 | W | 2.34 | 0 90 | 15 |
| | Chattanooga, Tenn. | 46.7 | 70 | 18 | 52 | 8.1 | 36 | NW | 2.31 | 0.51 | 11 |
| | New Orleans, La. | 57.3 | 81 | 34 | 47 | 9.8 | 34 | NW | 5.17 | 1.76 | 14 |
| | Memphis, Tenn. | 49.0 | 75 | 20 | 55 | 10.4 | 52 | SW | 3.22 | 1.13 | 7 |
| | Palestine, Tex. | 63.2 | 85 | 26 | 59 | 7 5 | 28 | S | 4.19 | 1.50 | 11 |
| | Average | 49.8 | 76 | 22 | 54 | 8.9 | 38 | — | 3.40 | 1.50 | 11 |
| Western Cities. | Helena, Mont. | 29.1 | 51 | —10 | 61 | 7.9 | 45 | SW | 0.66 | 0.29 | 10 |
| | Port Crescent, Wash. | 42.9 | 55 | 30 | 25 | 4.0 | 40 | SE | 5.10 | 0.56 | 25 |
| | San Francisco, Cal. | 55.4 | 78 | 43 | 35 | 7.4 | 30 | W | 0.46 | 0.24 | 4 |
| | Salt Lake City, Utah. | 37 3 | 74 | 10 | 64 | 5.1 | 47 | S | 1.95 | 0.66 | 8 |
| | Santa Fe, N. Mex. | 37.0 | 62 | 12 | 50 | 6.6 | 41 | SW | 0.27 | 0.23 | 4 |
| | Denver, Colo. | 35.2 | 74 | 2 | 72 | 8.2 | 50 | NW | 0.85 | 0.32 | 7 |
| | Yuma, Ariz. | — | — | — | — | — | — | — | — | — | — |
| | Average | 39.5 | 66 | 14 | 51 | 6.5 | 42 | — | 1.55 | 0.38 | 10 |

## BOOK REVIEWS.

U. S. GEOLOGICAL SURVEY.—Bulletin No. 88: The Cretaceous Foraminifera of New Jersey. By Rufus Mather Bagg, Jr.; pp. 71. No. 89: Some Lava Flows of the Western Slope of the Sierra Nevada, California. By F. Leslie Ransome; pp. 74. No. 149: Bibliography and Index of North American Geology, Paleontology, Petrology and Mineralogy for the Year 1896. By Fred. Boughton Weeks; pp. 152. Washington, D. C. Paper; 9 × 6 ins.; the first two illustrated.

REPORT RESPECTING THE YUKON DISTRICT.—By Major G. M. Walsh, Commissioner, Department of the Interior, Ottawa, Canada. Ottawa. Paper; 9¾ × 6¼ ins.; pp. 28.

This report covers the food question, royalty to the government, mail service, liquor dealing, law and order, river navigation, mining regulations, output of gold, general prospects, etc., in the gold producing region of Canadian Alaska. Maj. Walsh figures the output of gold for 1898 at about $10,000,000, and thinks that the Klondike will be a rich mining camp for the next 25 years. In the summer of 1898 from 3,000 to 5,000 people went up the Stewart River; but very little intelligent work seems to have been done. The trade of the camp is worth about $8,000,000, and in ten years it should be worth $30,000,000, and he calls the attention of Canadians to this fact.

NOTES ON THE NICARAGUA CANAL.—By Henry I. Sheldon. New and enlarged edition. Chicago: A. C. McClurg & Co. Cloth; 8½ × 5½ ins.; pp. 242; illustrated. $1.25.

As the author explains in his preface, this is a popular, and not a technical or professional discussion of the Nicaragua Canal project, and his avowed purpose is to stimulate popular interest in the enterprise. He believes that the tardy development and depressed agricultural interests of California, Oregon and Washington, are due to their long distance from markets and that a ship-canal through the Isthmus can alone benefit them. His visit to Nicaragua was made in 1895, and the lack of facilities made it impossible for him to visit the actual line of the canal between Greytown and Ochoa; though he did ride over the line between the Lake and the Pacific. All engineering data he obtained from the records of the Maritime Canal Co., in which he evinces entire faith, and from the report of the Ludlow Commission. The real interest of the work therefore lies in Mr. Sheldon's observations upon the people and resources of Nicaragua; the climatic conditions he found; the expenses of traveling and living, etc. These parts are useful to the intending traveler and are interesting to the general reader. Mr. Sheldon considers the conditions in Nicaragua very favorable to canal building. Notes upon other great ship-canals follow, based mostly upon personal inspection in 1897, and he gives an interesting general history of the Suez, Manchester, Chicago Drainage, Panama and North Sea-Baltic ship-canals. The discussion as to probable revenue and cost, method of construction and operation, etc., is very brief, and while the author evidently aims to be judicial, his enthusiasm rather carries him off his feet. For example, he thinks one great reason for building the canal is the trade of the Philippines, although the difference in the distance from New York to Manila by Suez and by Nicaragua, will be only 600 miles in favor of the latter, and the possibility of more frequent coaling on the Suez route would probably overbalance the difference in distance. Again, he says that the Nicaragua Canal will make New York and Liverpool "almost equally distant from Hong Kong," whereas as a matter of fact it will be no shorter voyage from New York to Hong Kong by Nicaragua than the present route via Suez. The book is written, however, in an entertaining style, and will doubtless find many readers.

ELEMENTS OF SANITARY ENGINEERING.—By Mansfield Merriman. Professor of Civil Engineering in Lehigh University. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 × 9 ins.; pp. 216; illustrations. Price, $2.00.

After an introductory chapter on "Sanitary Science," the author takes up in succession "Water and Its Purification;" "Water Supply Systems;" "Sewerage Systems;" and "Disposal of Garbage and Sewage." As an elementary work on sanitary engineering, adapted more especially for college use, the book is an excellent one. It outlines in a satisfactory manner the several branches of sanitary engineering named in the chapter headings, and so emphasizes the most important principles that they are pretty sure to be impressed upon the minds of the reader or student.

An excellent feature of the volume is a list of topics for further investigation at the end of each chapter. These not only point the way to specific sources of information, but, if followed out, cannot fail to broaden the minds of the investigators, by showing the connection between this and other branches of science, and by bringing the reader in contact with some of the best things in general literature. To illustrate the latter point, there is a reference to Charles Reade's "Put Yourself in His Place," for a description of the failure of the Dale dyke reservoir, near Sheffield, England, in 1861, and to Goethe's "Faust," for the reflections of the latter on his work in sanitary engineering.

It may cause surprise to some to know that the heating and ventilation of buildings is not given a chapter. The reason for not doing this, the author states, is that while these subjects are in the domain of sanitary science they do not pertain to the work of the sanitary engineer, which relates to matters affecting the public rather than the individual; also, that the architect, and not the engineer, is responsible for heating and ventilation. We believe there are many who will not agree with this line of reasoning, or who will at least feel that the ventilation of buildings is quite as much a public matter as the plumbing they contain, which receives attention in the book. The statement that the subject of ventilation has been adequately presented in other books, is hardly a reason for not taking it up here, as there is little on any subject in the volume before us that has not been treated much more fully elsewhere. In the section on "Water Supply," the author goes into hydraulics and hydromechanics to a rather surprising extent in a book on sanitary engineering. The subject of garbage disposal, on the other hand, might well have been discussed with greater fullness. The book has no index, a surprising omission to be made by an author with such a large experience, both as a teacher and a writer, and one which should be remedied in the future editions. Despite these minor defects, the book, as we have said above, is calculated to fill a real need as an elementary general textbook in this field.